DOCUMENT RESUME

ED 098 968 IR 001 351

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TITLE	Current Research on the Relative Effectiveness of Selected Media Characteristics.
INSTITUTION	Westinghouse Electric Corp., Pittsburgh, Pa.
PUB DATE	Oct 73
NOTE	123p.
EDRS PRICE	MF-$0.75 HC-$5.40 PLUS POSTAGE
DESCRIPTORS	*Audiovisual Aids; *Educational Psychology; Instructional Technology; Learning; *Literature Reviews; *Media Research; *Media Selection

ABSTRACT

The literature of research and theory on media, the psychology of learning, and the technology of instruction is reviewed. The focus is on discovering what is currently known about the intersection of these fields. Current thoughts and discoveries about brain structure and processing are discussed. The management of learning as a system is another topic reviewed here. Next, the relationship of certain media characteristics and instruction is discussed, namely: the picture, color, motion, and music. The effects that human perception and research should have on the design of materials and equipment are described. Finally, the optimum medium for different ages is discussed. (WH)

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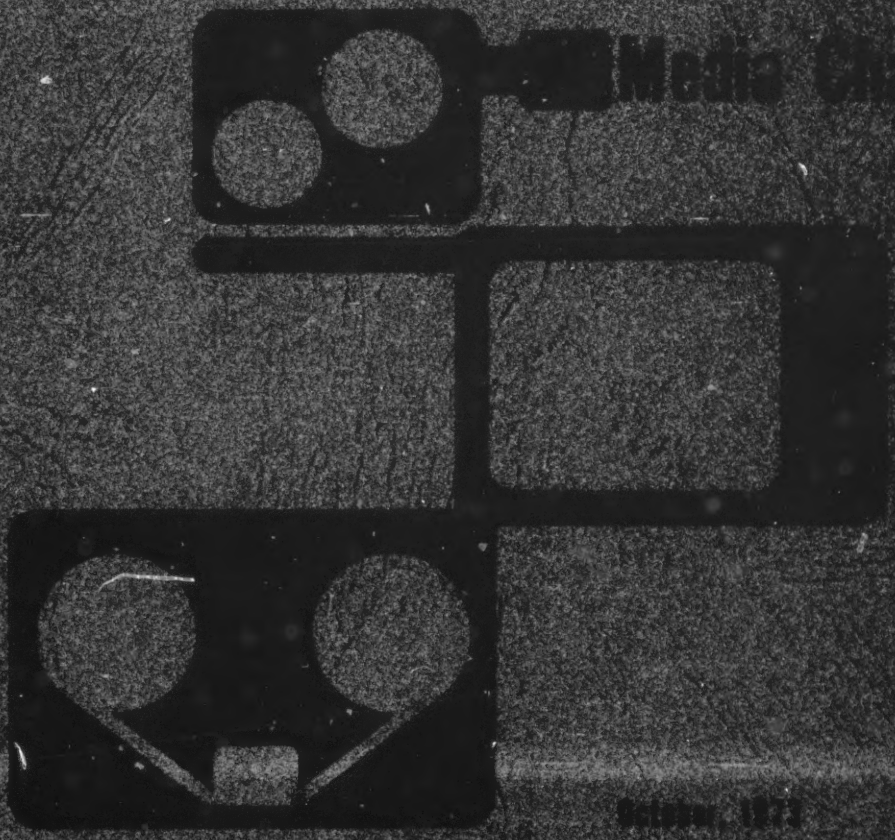

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CURRENT RESEARCH ON THE RELATIVE EFFECTIVENESS OF SELECTED MEDIA CHARACTERISTICS

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October, 1973

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PREFACE

Some years ago Westinghouse became interested in the problem which was called the "Man/Machine Interface Problem." Work in this area produced many experimental devices--and raised some questions about what constitutes a good means of transferring information between men and equipment. Norbert Weiner, in The Human Use of Human Beings, Cybernetics and Society, relates his theories of communication and control not only in mathematics, engineering, and electronics, but also in psychiatry and psychotherapy, neurology, physics, and certain social sciences. "What is important is not merely the information we put into the line, but what is left of it at the other end. This terminal apparatus may be regarded as a filter superimposed on the transmission line."

Work progressed on better terminals--primarily for computer application. But, some of the work extended into the best means of terminal presentation of information including full visuals, as well as printed alphanumeric information. In order to design something which could be used to receive full visual information, but was within the realm of the state-of-the-art in electronics, it became apparent that some tradeoffs would have to be made. Cost of equipment was a limiting factor.

It is believed that educational practice, in particular, can benefit from such work. To determine what is and is not required for good education to take place has required the work of many educational

researchers, drawn from many disciplines. Though some of the findings are known, much has been publicized only within the limited fraternity of researchers and little has filtered into popular literature. In addition, much of the confirming work which related to hypotheses advanced some years ago has only recently been completed.

In order to have a base of confirmed findings about education, it seemed good to draw much of the working material together and have a basic primer as a base for two kinds of work--progress toward better terminals and putting educational theory into practice. Therefore, the findings reported herein are for tentative use by two parties: researchers in terminal improvements and researchers in application of educational theory. The bibliography is drawn from educational theorists in the main, and seminal works are quoted at some length. It is hoped that this basic material can be used to suggest new directions and produce items of real value to educational practice.

SUMMARY

The Information & Knowledge Society

Daniel Bell defines the Postindustrial Society as one which is "organized around information and the utilization of information in complex systems ... a society uniquely dependent upon the compilation of theoretical knowledge." Inherent in discussions of such a society is the knowledge that, as knowledge begats knowledge, obsolescence of knowledge at a rapid rate is unavoidable and that "work" will change rapidly. Persons trained for one thing will require constant retraining in light of the new knowledge. All persons must continue their education throughout life. (p. 9-12)

A requirement will be delivery of up-to-date materials to those who need it on demand. This can only be done through skillful management--in this case, management of learning.

The Management of Learning

"The central problem of education is not learning, but the management of learning. Learning and the management of learning are not equivalent terms, any more than are learning and teaching. The so-called learning-teaching problem is subsumed under the management of learning problem. (Charles Hoban) (p. 14)

Hoban suggested the use of television for the distribution of materials. Robert Travers added a requirement that an information transmission system

should include a system for the external storage of knowledge in a way which will permit rapid access to the librariedmaterials. He recommended television as a prime candidate for delivering such material because it is a transmission system and its primary terminal--the ordinary television receiver--is widely distributed. (p. 15-16)

Both felt that the nearest thing to a universal media is television and that it possesses a unique characteristic (transmission) which makes it the most feasible equipment for development to carry all media--a means of "integrating" media.

Theories of Brain Research

The Penfield theory states that, "Whenever a normal person is paying conscious attention to something, he is simultaneously recording it in the temporal cortex." The theory was extended by Harris to conclude that the brain functions as a high fidelity recorder. Further work has produced much knowledge about how the brain actually does this. It is known that there are a temporary store, a permanent store, a selector mechanism, and a utilization system, so that the central nervous system can act.

Inputs of information which are required for survival are passed on before items of less importance (p. 17-18). The central nervous system evidently has limited capacity and appears to receive input from only one modality at a time. Because there is only room for a limited amount of information to pass into the utilization system at one time, there appears to be partial blocking of all information coming from other modalities when significant information is coming through one sense modality. (p. 19)

The processor of information appears to compress information and pass through only certain items. For visuals, this is accomplished through looking at the boundaries of shape, rather than the whole. We see outline shapes and recognize certain patterns. A man's head, an elephant shape ....

Broadbent and Travers feel that this indicates that there is only single-channel capacity into the central storage. Their research supports the generalizations that:

a. As long as information is presented at a rate equal to or greater than a person's ability to process information, there is no apparent advantage in using two channels carrying redundant information.

b. If the rate of presentation is less than the capacity of the student to process it, then there may be some advantage to using two modalities.

c. As the complexity of the learning task increases, the advantage of using the visual mode increases. Under these conditions, using the sound track for naming of the objects as relevant increases learning. (p. 20-21)

Auditory comprehension falls off more rapidly than video comprehension. To combat this problem, the English language employs a redundancy rate of 50 percent (p. 17). The visual channel is more dependable than the audio channel. That is, the visual channel makes less error, but processes less information than does the audio. There is no significant difference in recalled information between audio and video. (p. 22)

It has been found that audio is better than visuals for young children. But, for older persons with developed literary skills, visuals seem better. Considering all studies, it is concluded that there are factors influencing the relative effectiveness of both channels and that neither is inherently superior to the other. (p. 23)

The information rate for optimum learning is below 2-4 bits/second. If information is presented below that rate in any modality, learning will result. Capacity of the auditory channel is about 400 words/minute. Capacity for visuals seems to be about 2,500 pictures at the rate of one every ten seconds at 90% accuracy. (p. 49)

Significance of the Brain Studies

- Multiple sensory inputs are of value only when the rate of input of information is very slow.
- Since we learn from the "boundaries" of shape, providing total realism seems to be unnecessary.
- The relationship of the timing of the occurrence of events is of more crucial importance for effective learning than beautifully prepared materials.
- Visual/verbal order seems an effective combination for learning to take place. (p. 24)

Building on the reported research, what would appear to be good learning materials?

The Picture

A line drawing appears to be as good as a realistic presentation. "A detailed realistic picture, in being worth 10,000 words, may thereby say

too much." (Knowlton) Using line drawings to represent items results in faster, longer retained learning. Increasing realism in a visual does not always cause a significant increase in learning. In terms of economy of production and instructional effectiveness, the abstract-line presentation is most efficient. (p. 26-27)

Cartoons

Cartoons are an effective means of presenting visual material. (p. 28)

Additional studies report that there is a developmental aspect in the ability to learn from pictures. Studies on children found that they are incapable of recognizing unified wholes before about age 9-10. Piaget reported that details are not properly located by young children, which indicates difficulty with space perception. (p. 28-30)

Color

Color interests children, but there is no evidence that it helps them learn. There seems to be a certain maturation requirement at work. In young children, color actually appears to be "noise" and acts as a distractor from central material. It removes the information received from audio. (p. 31,32) If used, the color should be realistic. Children can be highly motivated by color, but do not learn from it before ages 9-10. (p. 35)

For older persons, the studies report an apparent lack of color affecting learning. However, there is evidence that it reduces the

rate of forgetting on long-term retention tests. Color increases recall of peripheral material, but does not increase recall of central material. People also have a higher opinion of color material, even though they may learn nothing from it. In fact, they learn better from the positioning of items. (p. 31-33)

It has been noted that it takes about four times longer to see color than black and white. When distinctions are critical, means other than color are recommended because about 8% of human males are color blind. Reds and greens are, of course, the greatest offenders. (p. 34)

Color, as tested, does not do much to assist one in learning material, but people like it better anyway. It is, after all, more realistic.

Motion

It has been found that, even when the subject to be taught has inherent motion, only about 40-45% of the motion shown is relevant. In other material, there is even less relevant motion, and it is estimated that about 90-95% of all motion could be eliminated with no loss of comprehension. (p. 37, 58)

Studies have shown that silent motion films are more effective than silent stills. But, if audio is added, sound still pictures appear to be as effective as sound motion. For teaching concepts involving time or space, slides are as effective as or more effective than motion pictures. (p. 38-42)

Why the Preferred Medium is Television

Researchers have concluded that television is the best all-around medium because it can carry all others--that is, it has distributive powers.

Studies have produced some interesting information about television. Some of the findings are these:

- Students learn more when they respond actively during the program.
- Varying class size has no effect on learning.
- Programming has an effect on the programmer, if not the student, so it appears that teachers should write programs.
- A useful technique for revising programs is on the basis of what students did not learn from them. An unsatisfactory method is to show television teachers their lessons.
- Teachers will choose television over other media when it is available to them.
- There is no difference between viewing programs at home versus in a classroom, except that older participants apparently learn more at home.
- Personal initiative in TV viewing, allowing a person full control over directing his own attention, seems crucial to learning. (p. 51-57)

The Case for "Integrating Media"

"When at least one completely justifiable use for television calls on its full potentials, it can be applied successfully as a universal instructional medium. Under such conditions, a television system can be utilized for any telecommunication purposes, in full or partial modes, audio only, still pictures only, or simply as a transmission medium to distribute recorded materials. (Bretz) (p. 59)

"The operational principle is to move information and learning materials to the people and reduce as much as possible the travel of people to the places where learning materials originate or are displayed. The right size technology is that size and complexity which are necessary to serve well the essential education-learning functions without excess or waste of resources." (Carpenter in Schramm, ed., 1972) (p. 60)

Introduction

In 1970 the Committee on Science and Astronautics, the House of Representatives, U. S. Congress, held hearings to determine the proper role of Government in managing information and knowledge. Gathered to testify as to the philosophical reasons for accepting the premise that today's society is more complex and demands new answers to problems besetting it were major theorists in the esoteric "science" of predicting the future.

Daniel Bell, who gathered the group which produced the Daedalus, Summer 1967, issue dealing with the year 2000 for the American Academy of Arts and Sciences, has been credited with popularizing the idea that the United States will be among the first nations to enter what is termed the "Postindustrial Society," (between $4,000-$16,000 per capita) sometime before the year 2000. In fact, he predicts that we do not even have 15 years to wait. Aligned with him is Herman Kahn, the man who forced America to think about the "unthinkable."

Daniel Bell defines the "Postindustrial Society" in the following words:

> A preindustrial society is essentially one based on raw materials, in which there are diminishing returns. An industrial society is organized primarily around energy and the use of energy for the productivity of goods. A postindustrial society is organized around the information and utilization of information in complex systems, and the use of that information as a way of guiding the society.

> There is another fact about a postindustrial society. It is not just a service society in terms of where people work; it is not just an information society on the basis of organizing the flow of knowledge; it is also a society uniquely dependent upon the compilation of theoretical knowledge.
>
> It means the scarcest resource to the society is essentially talent (or human capital).

Herman Kahn pointed out that John Von Neumann, writing in the June 1955 Fortune, thought that a number of technological trends would seem to come to a crisis stage sometime around 1980. Kahn, however, opted for 1985 as the modal crisis year. In either event, we do not have to wait for the year 2000 to find the future. It is already uncomfortably close at hand.

How do we prepare for the unknown? What tools will be required? We must prepare them now, for their use is not far off.

The social group expects "education" to be in the forefront of preparing persons to take up their responsibilities to the others in the society. The formal schools have accepted this responsibility and, thus, are faced with a two-edged sword. Because they have accepted and taken the responsibility, they are obligated to educate for the unknown--jobs which are not dreamed of, life-styles only hinted at in today's world.

Thomas Green testified that "schooling" must no longer be separated from "working" and that now all must accept the challenge. What he has proposed is that the "employer" (i.e., the other members of the social group) now must share the burden by providing continuing training. The "schools" will provide materials, but persons can choose to "study" anything, when they wish, as they wish, from the cradle to the grave.

"Serial careers" means that one can no longer expect to train for a particular slot and continue it all his days. Peter Drucker, famous for books on management, has maintained that "management" as we now know it--of raw materials, of funds, etc.--will become still more difficult, because it now demands that people not be "managed" to do more productive work in a shorter time but that a benevolent attitude toward the aspirations of "employees" will be required. The strong back or the even stronger machine will not be the manager's main concern but rather the unique capabilities of an individual. The best manager may be judged by his abilities as a "guidance counselor." Inherent in this idea is the knowledge that choice of an early career can be wrong and that a way to rescue wasted talent without scarring the individual is a requirement when there are so many tasks to be done.

Thomas Green chose to highlight his concern for these problems in the following passage:

> The growth of education outside the formal system has probably been the most significant change in education over the years just past. Current estimates indicate that in the United States in the current year (1970), more people will be receiving instruction of a formal sort outside the formal educational system than within it. We need to view work itself as organized for its educative value instead of organizing education for its value to work.
>
> It is, after all, the underlying principle of a knowledge society, that a man's marketable skills are no longer tied to a specific set of tasks within one organization. Knowledge skills are polyvalent, i.e. applicable to an enormous range of tasks.
>
> Thus, a viable organization will arrange work to develop the capacities of people, rather than simply use the capacities of people to accomplish the work. Think what that means! It

> means the growth of serial careers, permitting access to different careers, even ones for which (people) are not well prepared. If there are multiple paths, there are graceful exits (from unpromising positions for which one finds himself unsuited).

Faced with a problem of magnitude, U. S. ingenuity is in its glory. The very thing which looks impossible tempts many to try to find the solution. And what is the problem? It is managing in such a way as to enable all to develop as full human beings, an opportunity never before given to people in human history. By these standards, the brains best able to work on problems like "energy crisis" can be brought to bear, because the need to find shelter for the night and food for the morning is less pressing than it had been before or remains in much of the world. To maintain a high and rising standard of living will require that all must accept the responsibility of continuing education, so that the problem-solving can continue unimpeded. Special knowledge will be required at each step, and we cannot wait 20 years to train "experts." People in place will have to be trained, on short notice, for service on a problem which, once solved, will obsolete their service. (Fortunately for those who may feel disheartened by this knowledge, it seems that there is always another problem when one manages to solve the original to some satisfaction.) The problems of persons who are "obsoleted" and simply let go are too large to discuss here; but obviously, society cannot afford to carry chafing retirees when there is much to be done. It would be a service to all to continue education through the 70's, not just through the 1970's.

CHAPTER I

The Management of Learning

In 1965 there was ferment in the land. A book, published in about 1962, had put Americans on notice that they were already entering an era which had crept up on them. It was dubbed the "knowledge society." It got its name from the fact that a large percentage of the Gross National Product (nearly 9%) was discovered to be calculated not in goods, but in "education." The Sputnik Era had alerted many to the need for improvement of the formal schooling patterns in the U. S. and the requirements for training citizens to their full potential. Still, it had not yet been graphically pointed out that large numbers of persons were, on their own recognizance, making provisions for their own training. Trade schools, hobby schools, abounded. Pressure was brought to bear on the formal educational system to provide enrichment or job-upgrading courses. Industry had responded with large numbers of "teaching machines," meant to provide help where teachers were in short supply.

In 1973 there was an abundant supply of newly graduated education majors and no jobs for them. What had happened? As usual, we had responded to a need with a glut on the market. Just as the need arose, means were provided for reaching a goal. If we needed teachers, we turned them out by the thousands, then by the millions.

But the problems do not go away. The reason is that we identified the wrong culprit. Post World War II "baby booms" turned into a bust,

clearly indicated by the sharp downturn in birth rate starting in 1967. There are as many theories as to why as there are "experts," but the fact remains that the new problems will have to be solved. And a problem will be delivering up-to-date materials to those who need it on demand.

Charles Hoban, working at the Annenberg School for Communications, the University of Pennsylvania, thought about these things in some detail in 1965. His response is still the challenge faced today: the management of learning.

Hoban described his thoughts thus:

> Take for example, the concept educational media. What we actually include in the term is machines. When we consider the part machines play in education, we are forced into a consideration of man-machine systems. ... a consideration of technology ... educational technology ... or technology in education.
>
> It is frequently said by educators and educational researchers that the central problem of education is learning. Learning is a process central to human survival. The central problem of education is not learning, but the management of learning. Learning and the management of learning are not equivalent terms, any more than are learning and teaching. The so-called teaching-learning problem is subsumed under the management-of-learning problem.
>
> Central to the (educational institution's) problems and intrinsic to the broad problem of the management of learning is the fact that educational television for noncaptive audiences is underutilized.
>
> No matter what educational media is introduced, the situation into which it is introduced is transformed by the introduction. Acceptance of management of learning as a central problem of organized and institutional education would, at least, permit the admission of a wider range of alternative procedures.

Hoban quotes Robert Lewis Shayon (1961):

> The word "pandemic" was coined by Professor Wh. H. Cowley of Stanford University's Department of Education ... Professor

> Cowley asserts that three kinds of individuals are to be found in almost every society. The first is the "logodemic." He is the scout on the frontiers of knowledge, concerned exclusively with discovering the frontiers of knowledge, and adding them to the world's stockpile of knowledge. At the other end of the spectrum is the "practidemic" type. He is the individual who puts to practical use the knowledge discovered by the logodemic man. Between them is the "pandemic" man. His job is to mediate between the others. This mediation is necessary because the logodemic speaks an esoteric jargon which only other logodemics understand ....
>
> Pandemic man is the man who can get the general drift of the logodemic's ideas--translate them, and communicate them to the practidemics. He is a generalist ... able to catch the essentials of the specialists' mysteries ....

Then, Hoban continues:

> Scarcely one of us can fail to itemize a depressingly long list of studies in which the results are untranslatable into meaningful terms.
>
> I would add one more step beyond all-out demonstration to the progression: <u>implementation in educational practice</u>.

Joining Hoban in the battle for a better way of delivering needed materials when and where desired are Stuart Cooney, William Allen, Robert Travers, and others. Cooney and Allen suggest that a computer-controlled access and delivery of information offers promising potential for providing radically improved fit of the messages to the changing needs of the individual. Travers (1964) says:

> The transmission system must provide an effective means of external storage. Man behaves in many ways as if his capacity for storing information was very limited. In order to overcome this limitation, he has devised auxiliary information storage systems external to himself. <u>An information transmission system, beyond the elementary school level, should provide a system for the external storage of knowledge in a way which permits the learner to have rapid access to it</u>. Man's

> limited storage capacity implies that he should leave an educational institution armed not just with the knowledge and skills which he has acquired, but equipped also with an external store of knowledge from which he can skillfully retrieve information.

And Allen, in 1967:

> It should be pointed out that television is a carrier of information to the learner and probably possesses no particular characteristics that would make it more effective than any other instructional medium in teaching factual information. The educational differences between (other sources) and television are those related to the method of image display, the control that can be exercised by the teacher in using them, and the system of distribution of the images.

The National Cable TV Association in a report entitled Cable TV and Education (1973) estimates that TV sets are standard equipment in 77 percent of all public elementary schools and 69 percent of public high schools. These TV receivers are also turned off more often than they are turned on. To the cable TV people, "This constitutes gross neglect of its potential. Television ought to be used to bring students educational experiences not possible within the physical or financial bounds of the ordinary classroom." To this could be added, nearly every American home and hotel room is presently the host for a TV receiver.

Here then is a possible answer to solving the problem of delivering material to those who wish to learn, when they wish to learn.

CHAPTER II

A Theory and How It Grew

In 1950 nobody knew how the brain functioned. The theories that the brain has a chemical function or an electrical impulse function had not really been pursued. A doctor at McGill University, Montreal, Penfield, was treating focal epilepsy with brain surgery. During the course of these operations, he conducted a series of experiments during which he toucned the temporal cortex of the brain with a weak electric current transmitted through a galvanic probe. The patients, under local anesthesia, were able to talk to Penfield. He found that the electrode evoked a single recollection, not a mixture of memories or a generalization. The evidence seemed to indicate that everything which has been in our conscious awarene[illegible]s recorded in detail and stored in the brain--and is capable of being "played back" in the present.

More significant, not only were past events recorded in detail but also the feelings that were associated with those events. He concluded that the memory record continues intact even after the subject's ability to recall it disappears.

Thomas Harris (1969) took this one step further and concluded: The brain functions as a high-fidelity recorder, putting on tape, as it were, every experience from the time of birth, possibly even before birth. (The process of information storage must involve data reduction and coding; but however the recording is done, the playback is high fidelity.)

Penfield concluded that "whenever a normal person is paying conscious attention to something, he simultaneously is recording it in the temporal cortex. These recordings are in sequence and continuous." The thread of continuity seems to be time. That is, the original pattern was laid down in temporal succession. Furthermore, a new experience is somehow immediately classified together with records of similar experience so that judgment of differences and similarities is possible.

Brain research has continued in many fascinating experiments using animals, and many of these studies are well known. In 1969 Mary C. Potter and Ellen I. Levy concluded that, in working with human subjects, "the results support the hypothesis that rapidly presented pictures are processed one by one for precisely the time each is in view and are not held with other items in a short-term store, as has been reported for verbal material." This appears to support Penfield's conclusions from the early experiments.

Temporary Storage:

In 1958 Broadbent proposed the existence of a temporary storage device which held signals for a few seconds. Hull had used rats; Broadbent had used human subjects. Hebb had proposed that the nervous system is so equipped. The controversial issue was whether information held in temporary storage can be transferred directly to permanent storage without entering the utilization system. Studies on incidental learning suggest that they do, but there are others who argue that such material does not enter the utilization system.

Licklider introduced the concept that incoming information is correlated or matched with previously stored information. This correlating process appears to be important for all organisms having complex nervous systems, since heeding something novel in the environment assists in survival. Inputs of information of high value for survival may be passed on before items of a more trivial nature. It is known that persons in a need state are more active in seeking solutions to problems--of hunger, thirst, and higher order items.

Limited Capacity of the Central Nervous System:

If the selector mechanism did not function, the utilization system would become jammed with information and could not function effectively. Hence, there is a system of priorities. Broadbent said that such a filter mechanism was essential for the final utilization of information, since the final process appeared to involve a single-channel system of limited capacity. Such a perceptual system model creates a problem, for it is clear that transmission of information on both the auditory and the optic nerve cannot be represented as a single channel system. Therefore, there must be an analysis of which channel to select on the priority system before reaching the selector mechanism, which makes a final decision upon items which will be acted upon. When information from one sensory modality is being used, the inputs from other modalities are blocked but are continuously monitored for priority of access. However, there is a partial blocking of information coming from other modalities when significant information is coming through one sense modality.

Permanent Storage:

Hebb proposed that temporary storage is produced by nerve impulses being transmitted through circular chains of neurons. But, long-term storage is more complex. Travers assumed that the information stored is highly compressed and fragmented, but capable of being reconstructed in a way that approximates the original stimulus. Cherry suggests that less may be stored of visual inputs than Penfield's evidence would suggest.

Compression:

Visuals seem to be transmitted through boundaries. Attneave states that a representation which emphasizes boundaries and de-emphasizes other information is an effective means of transmission. The line drawing satisfies this condition. Travers points out that some individuals are more effective visually, others verbally. In an audiovisual transmission, an individual can choose whichever he can most effectively use. In some of Travers' experiments redundant information was played through both channels, faster and faster. His observation was that "at the highest speeds, some subjects tended to close their eyes while others placed their hands over their ears, indicating that only one transmission was being received. The model implies that the main restriction on the amount of information that can be handled is derived from the fact that highest processing level is a limited capacity system. If this is so, then one might expect that as much information could be received through the ear as through the eye...." (1966).

The Broadbent-Travers line of research seems to support the generalizations that: (a) as long as information is presented at a rate equal to or greater than a student's ability

to process information, then there is no apparent advantage in using two channels carrying redundant information; (b) if the rate of presentation is less than the capacity of the student to process it, then there may be some advantage to using two modalities; and (c) as the complexity of the learning task increases, the advantage of using the visual mode increases. Under these conditions, using the sound track for naming of the objects on the sound track as relevant increases learning.

The two items which have been considered constants in general education theory are that: more information is acquired when the same information is transmitted simultaneously through both channels than when only one is used and that the more realistic a presentation, the more effective will be the transmission of information. Juxtaposed against these statements are the work of the psychologists and the physiologists working in perception and information theory.

Rate of Transmission and Channel Switching:

Feigenbaum and Simon went further than the preceding research has indicated, and hypothesized that information was lost in the about 200 milliseconds required for channel-switching when that occurred. Cherry supported that contention.

Two sources of information coming through the same or different sense modalities can be utilized simultaneously if the rate of transmission is very low. When Reid tested for rapid switching between two channels at a relatively high information rate, he got the same results as Feigenbaum

and Simon; that is, the switching time appeared to be time-out from learning. Moreover, the subjects became quite hostile. Auditory comprehension falls off more rapidly than the video, and the audiovisual presentation begins to show an increasing advantage over either one alone until two different tracks of information are rapidly switched from one channel to the other.

Capacity Limit:

At any rate, although human preference for complex experience seems evident, tolerance for it appears to be limited.

Hsia (1968) points out:

> The simultaneous AV channel inherits the advantages and disadvantages of both A and V channels, and presumably has advantages over the A and V only if its A and V stimuli are closely identical, such that one channel provides cues and clues for the other channel when the number of clues is no more than optimum, or when the sum of information is not in excess of the capacity of the central nervous system, as additional cues might cause distraction and conflicting responses.

Since it is believed that there is a capacity limit for any physical or physiological channel, what is total capacity? Any information beyond the limit is lost and the loss is called "equivocation." In addition, there are "error" and "noise," unwanted information. In order to combat these three, any communication system usually employs the redundancy principle, which in the English language is 50 percent.

Which is Better--Seeing or Hearing?:

It has been found that audio is better than visuals for young children. But, as language-skills are developed into literary skills, visuals seem better. Considering all studies, it must be conceded that there are factors

influencing the relative effectiveness of both channels and that neither is inherently superior to the other.

The problem of communication efficiency is to reinforce one channel with the other while keeping down between-channel interference effects.

As a rule, a visual presentation can contain more information than an audio presentation. What appears on a TV screen far exceeds the input capacity of the central nervous system. Therefore, a selection of information is made and the rest discarded, though not at random or by chance. When the information rate is below 2-4 bits/second, any modality will do, since this is optimum learning rate, as established in several studies. Each of these studies found that, if the information is presented at a low enough rate, learning will result.

Redundancy:

Redundancy is probably the most effective communication device man has found to cope with equivocation and error. However, it inevitably raises the cost of information processing in terms of time and capacity, as redundancy necessarily takes up information space and/or time. In order to reduce equivocation and error, it is necessary to increase redundancy, but to increase redundancy is to decrease information. This is the communication theorist's perfect dilemma.

In the Hsia study it was found that the visual channel was more dependable than the audio channel; whereas, the audio channel was more efficient than the visual channel. The visual channel made less error but processed less information than did the audio. There was no significant difference in recalled information between audio and video.

What is the Significance of These Studies?:

- The evidence seems to indicate that multiple sensory inputs are of value only when the rate of input of information is very slow. The silent film with an alternation of picture and print seems as good as anything.
- Providing total realism would seem to be unnecessary. Man responds to highly selective information and cues. A learner should not have to discriminate between relevant and irrelevant details. A line drawing of the wiring of a television receiver might be as effective for kit-assembling as a picture of a box, with no identifying labels.
- It would appear that the relationship of the timing of the occurrence of events is of more crucial importance for effective learning than beautifully prepared materials.

Incidentially, a study by Chan, Von Mondfrans, and Travers on the value of using special effects, such as music, color, etc. showed that a more glamorized visual version of a particular study material produced greater learning with the printed materials but at the expense of the auditory channel. The total information received was the same, but the distribution of the source of information was changed.

Gropper concluded that "A single word, as has been aptly put, can be worth a thousand pictures." That is, words serve a cuing function. He found that visual/verbal order was an effective combination for learning to take place.

The general conclusion that emerges is that more often than not, there is no learning advantage to be gained by a fancier, more complex treatment.

Twyford (1951 found a negative correlation between how much students reported liking a film and how much they learned from a film. As a rule, technical slickness does not increase the amount learned from a film.

CHAPTER III

The Picture - Realistic or Logical?

Line Drawings Most Effective:

Attneave proposed that we learn to distinguish shapes from boundaries and, thus, that a line drawing was as good as a realistic presentation. Knowlton (1966) went a step further and concluded that "A detailed realistic picture, in being worth 10,000 words, may thereby say too much."

> Just as the visual world is sometimes too complex for some purposes, so, too, for some purposes, are realistic pictures.
>
> This is the reason why barren, highly schematized pictures are often used. By schematizing, one hopes to eliminate noisy, noncriterial attributes. When "schematization" is carried to its logically furthest extreme, the elements in the state of affairs represented are represented in a totally arbitrary fashion. When this occurs, one has what is here called a logical picture: a visual representation wherein the elements are arbitrarily portrayed, while pattern and/or order of connection are isomorphic with the state of affairs represented.
>
> An example of a logical picture is a circuit schematic. Another is a highway road map ....
>
> Thus it is that a logical picture would seem to have a great potential for signifying relationships (or structure). Indeed, it would seem that in some cases, it is only by means of the logical picture that it becomes possible, iconically, to unambiguously signify relationships between elements. (Knowlton)

At the Pennsylvania State University, the Division of Instructional Services has been conducting experiments since the late 40's. A large

report, filed with the Navy, formed the backbone of much of the present research. Under the direction of F. M. Dwyer, a series of tests have been run to determine the best types of visuals to be used for various learning situations and ages of participants. Most of this work has been done with ninth through twelfth graders and college students. In a series of articles reporting the results of these tests (1967, 1968, 1969, 1971), a consistent relationship between using line drawings to represent items and faster, longer retained learning seems to be shown. He states it thus:

> The use of visualization to illustrate verbal instruction does not automatically improve student achievement of all types of learning objectives.
>
> Increases in realism in a visual does not always cause a significant increase in learning. There are practical limits beyond which increased realism will not result in increased learning.
>
> The effectiveness of the line presentation treatment in facilitating student achievement on the delayed retention testing is in accordance with recent literature ....
>
> Another possible explanation for the poor showing of the realistic photographic sequences--(is that) the initial impact of excessive realistic detail may be sufficiently strong to detract attention from relevant and important learning cues ....
>
> In terms of economy of production and instructional effectiveness, the abstract-line presentation was most efficient in promoting S's achievement on the drawing tests, identification test, terminology test, comprehension tests, and total criterial test. All S'd viewed the instructional presentations for equal amounts of time. The line drawings contained limited information and could be perceived and absorbed quickly.
>
> Much of the visual material appears to be incorporated in instructional presentations merely for the purpose of filling the video channel.

> The presentation using abstract line drawings should be used to complement oral instruction designed to facilitate student achievement in drawing, identification, and total criterial tests. The oral presentation without visuals should be used to facilitate student achievement of educational objectives measured by the terminology and comprehension tests.
>
> The oral presentation without visuals was as effective as the visually complemented treatments on four of the five criterial tests. The exception was the drawing tests in which the abstract line presentation was found to be significantly more effective ....

Dwyer's tests are an extention of the Hoban and Van Ormer study for the Navy on Instructional Film research, in which they pointed out that cartoons were an effective means of presenting visual material.

> Cartooning omits all except the essential detail and often exaggerates the crucial characteristics of appearance and behavior. The cartoon thus seems to be an adaptable medium for presenting crucial cues.

Learning from Pictures:

Moore and Sasse (1971) tested the theories of Piaget, Travers, and Miller (1938) that there is a developmental aspect in student ability to learn from pictures. They concluded that line drawings are generally the most effective type of picture and that photographs seemed to be the least effective type of picture when tested across grades three, seven, and eleven.

Travers and Alvarado (1970) pointed out that it was of utmost importance to discover "when children become capable of interpreting the dynamic properties of pictures, for until a child can do this there is little value in presenting him with most of the pictorial materials that are introduced into his education." Piaget and Inhelder (1956) and Miller (1938) had

pointed out that young children, when asked to reproduce a drawing, tended to reproduce the outline with considerable accuracy; but the details were not properly located, indicating that there was a problem in space perception. In fact, Miller had tested third grade children and found that they could describe correctly only 20% of the main ideas in the pictures which were used in their school books. Items in the pictures were seen as isolated rather than as parts of the unified whole.

Travers undertook a study on the development of the perception of pictures by children. The children ranged from nursery school age (4) through sixth grade (12). The study showed that young children latched onto a particular object in the picture and failed to observe other items. On successive trails the young children typically reported the same object again and again. It was found that they were incapable of recognizing unified wholes before the third or fourth grade (age 9-10). He pointed out that the use of color gave a lifelike appearance which helped them recognize a dynamic, ongoing scene, in the still picture. He goes on to explain his reasoning:

> A minimum condition for receiving information from a picture in that the person involved attend to it. Living organisms are systems with a limited capacity for handling information and have to be selective in what they attend to. If there were not, they would constantly find themselves swamped with large volumes of useless information. Some simple rules seem to guide the attention process in most higher animals. They avoid immediately returning to the part of the environment they have most recently inspected, and children will turn to a new book rather than go over the one they have just finished. The tendency is a deepseated and primitive tendency, important for survival in the wild state. An animal that kept on inspecting the same parts of its environment would be unlikely to find the food it needed.

> Man's perceptual system functions as an information system that requires a continuous input of new information. When new information fails to come from the environment, activity is initiated and continues till new information is received. Deprive a person of inputs of new information by placing him in a dark soundproofed cell, and he finds the situation absolutely intolerable ....
>
> Children do, of course, frequently return to familiar pictures and books and this form of behavior is not inconsistent with what has been said.
>
> A related finding is that humans show a preference for viewing visual displays that have some complexity to them. Such a preference is shown at a very early age. This does not mean that more is learned from a complex display than a simple one, but only that the complex displays are viewed longer ....
>
> We suspect that the primary function of most illustrations is to make the product more marketable rather than to stimulate the pupil or to make him more knowledgeable. This is the reason why so much pictorial material to which children are exposed is designed in terms of adult tastes rather than in terms of the learning requirements of children.
>
> The primary information-giving function of pictures is to handle that information which cannot be readily coded into words. If information is readily coded ... then there may be no need for a picture .... That nasty, misleading cliche, that a picture is worth a thousand words, should have been laid to rest long ago in the graveyard of half truths. Pictures are useful when one is concerned with transmitting crude and rather imprecise information about the environment.

Eye Movements:

Wolf (1970) analyzed eye movement of subjects viewing motion picture films and revealed a continuum of movements. No movement, or minimovements, were related to intelligence, but age and learning did not affect the viewing habits. Students in grades 6, 8, and 11 were divided and tested. Results showed that subjects look at a few well-defined areas of a screen. In planning visuals, it might be well to consider where the subjects normally focus.

CHAPTER IV

Color -- Should You or Shouldn't You?

The study of color versus black and white recurs in the literature again and again. The reason is that--overall--people couldn't find much relationship between the addition of color and the effectiveness of learning. Empirically, it seemed like a good idea. But structured tests seemed to reveal little support for the contention.

Kanner (1968) reviewed all the evidence and found that "as measured by objective tests, the findings reveal an apparent lack of color effectiveness upon learning."

A consistent finding is that, as the number of color coded items increases, the value of color as a cue for selecting important information decreases. In a very dense visual display, color coding at some minimal level helps in picking out important information; but if you increase this use of color, its value as a selection cue diminishes.

Hidden in the VanderMeer reports of studies conducted in 1952 were the findings which would change the opinions, but it remained for Dwyer to restate the findings in 1969. VanderMeer found that there were no differences between color and black and white films in the immediate tests of learning. He reported, however, that the results suggested that color combinations reduced the rate of forgetting in retention tests.

Dwyer retested for the long-term retention rate and found there did seem to be some latent learning, in some cases. He then stated that:

- For specific objectives the addition of color in certain types of visuals appears to be an important instructional variable in improving student achievement.
- Different types of colored illustrations differ in the effectiveness with which they facilitate student achievement of identical educational objectives. (1971)
- In terms of economy and instructional effectiveness the black and white abstract line presentation was most effective in facilitating student achievement on the drawing, identification, and total criterial tests. The colored abstract line presentation was the most effective presentation in promoting achievement on the terminology test. (1968)

If color makes no difference in learning on a general basis, why do we feel intuitively that color is better than black and white? Students queried in these studies and others not cited have responded that they liked color better (but the film subject matter actually affected the student's attitudes more than color).

In a study by Katzman and Nyenhuis (1972), an attempt was made to find out what really did happen with the addition of color to visuals. Deutschmann, Barrow, and McMillan (1961), Kumata (1960), and Schaps and Guest (1968) seemed to have one finding in common--additional visuals cues, such as those provided by a live presentation or the addition of color, seemed to increase recall of peripheral material. Peripheral material is defined as any media content that is not relevant to the basic information, message, plot, or theme being presented. The results of the Katzman and Nyenhuis study tended to support the idea that color

"increases recall of peripheral material, but does not increase recall of central material of any sort." They also found that people tended to have a higher judgment of color material, even though the net result in learning was negligible, to say the least.

To make sure of the results, they ran the experiments again, with the same results. Therefore, they concluded that: it appears that the addition of color to an audiovisual presentation raises the judgment of certain aspects of that presentation and improves learning of pictorial material that might be considered peripheral, irrelevant, or detail. Color does not improve learning of central material.

Isaacs (1969) concluded that color coding made no significant difference in reducing the number of trials required to learn the types of material presented in his study. Tolliver (1972) concluded that college students learned better from the position of items, rather than from color, on 16 mm motion film.

Hoban and Van Ormer had concluded that color appeared to be a distracting influence under some of the conditions they studied and attributed this to the fact that it sometimes distracts the learner from important cues. They concluded that to use color effectively, one would first have to determine what the crucial learning cues are and then emphasize these cues by the color medium.

Reich and Meisner (1972) decided to attack the problem in another way. Perhaps color changed the nature of a program in a fundamental way. Dichter (1969) had concluded that color is a more emotionally involving medium. Scanlon (1967) had thought that "color changes the emotional impact of

television; that it alters the importance of the spoken word; and that color makes viewers more participants and less observers. In short that color is a new language." They set out to find if this were true. Their finding was that color television did not seem to be at all different as an instructional medium from black and white. Their final conclusion:

> Color is enjoyed much like the cherry on a sundae--it's nice to have it there, but it doesn't do much to change the flavor of the ice cream underneath.

The Question of Color Blindness:

Richards and Macklin (1971) decided to study the seeming inability of some people to read colored overhead transparencies. What they concluded was that color blindness can be a real hinderance for a student. Designers should take heed.

> For brief exposure, it takes about four times longer to see color than black and white. Earlier studies indicate that the brightest color contrast is only 35 percent of black and white contrast. Recent work of Guth and Eastman (1970) gives measurement of color contrast and visibility that should help in making better colored transparencies. When luminance contrasts were over 40 percent, color had little effect on visibility. Colors that are confused by people with deficient color vision should be avoided when making color-coded transparencies, e.g., protans confuse green and tan, dull green and brown, greenish-blue and pink, and blue and dull purple; dutans, green and brown, bluish-green and pink, greenish-blue and purple, blue and blue-purple, and tritans, blue and dull green, blue-purple and yellow-green, and pink and orange. Protanopes confuse greens and reds although the reds appear darker than they would in normal color visual and deutanopes may not see greens and reds of equal luminance as different. Unless properly used, color coding may be a source of confusion, or not seen, by about 8% of men and .5% of women. When distinctions are critical, means other than color should be used.
>
> Reds and greens of similar brightness and pastel shades cause greatest confusion for men with deficient color vision.

Color and the Young Child:

Some of the most interesting experiments are continuing at the University of Southern California, Los Angeles, in the Instructional Services unit. Booth and Casey have done some experiments which would indicate that color is not a necessary ingredient in children's learning materials, which seems to be in direct contrast to what all primary teachers and most parents believe. In a telephone interview, Casey reported:

> Color is "noise" to first and second graders. It removes the information received on the audio track. By fourth grade, if color TV is used at home, the color is used for information; if black and white TV is used, the color is not used for information.
>
> Blacks perform at about 2 grade levels lower; that is, they respond to color at an earlier age.
>
> Color is part of the "dog food syndrome." Dogs don't buy dog food; people do. They buy what they like, or think the dog will like.

To which Travers (1970) adds:

> Preference for realism appears to extend to some degree to the matter of color. Children not only preferred realistically colored pictures, but they also preferred the uncolored illustrations to the unrealistically colored ones.
>
> (However, the conclusions need some qualification. Commercial producers of color film for amateur photography long ago discovered that the public prefers to buy film which tends to present colors more saturated than those found in nature. Attempts to sell color film that provide strictly realistic colors have been unsuccessful.)
>
> Simplicity and fidelity are quite compatible principles to apply at the lower levels. Most pictures for the lower elementary grades do not satisfy these criteria. Many ... are stylized drawings.... The coloring is typically unrealistic. The pictures presented ... are not designed in terms of the tastes of children. These are the illustrations least preferred ... by the elementary school pupil audience for which they are intended.

Wilbur Schramm (1972) adds that in talking about color, per se, we neglect to include the situation in which color is necessary--when color is the element being taught. He also points out that motivation may be increased with the use of color, so it should not necessarily be ignored.

Kanner (1968) believes that words can be substituted for the actual perception of color and that this seems to be an adequate substitute.

Color and the Color TV Receiver:

Rudy Bretz, RAND Corporation, points out a rather interesting phenomenon. That is that a high-quality TV image on the home receiver is not determined by the sending location but by the condition of the receiver, along with the homeowner's (or teacher's) relative skill in picture adjustment. He makes his own feelings known about most people's tuning ability with the following, "One can only conclude that realistic color is not a very important factor in entertainment television."

> If it is heightened realism which color television is to offer instruction, the prospect is dim. If classroom receivers will be largely consumer product models, as black and white sets in the schools are today,and operated by school staff personnel with little more technical expertise than home viewers, as black and white sets in the school are today, realistic color can hardly be expected.
>
> If it is increased persuasiveness, added emotional appeal, a positive attitude, that color is to bring to instruction, I am afraid the chances are also fairly dim. To be effective, color must be pleasing.

To be fair, he adds the following:

> Progress, however, is inevitable in the field of technology. I believe we will see the universal use of color for all pictorial purposes, except for special reasons. Until that day, I believe black and white will be fully sufficient for our present instructional purposes, and, in comparison with unrealistic color, definitely superior.

CHAPTER V

Motion, Music, and Other Subjects

Motion:

Before it was possible to choose many forms of audiovisual materials, there was little problem in showing what was meant by a particular object. Word descriptions were used, with perhaps a few sketches and, later, some woodcut stills. Only in the middle of the Twentieth Century could we ask, "Is motion required to enable a learner to learn?" Since it is possible, it is assumed to be indispensable.

Researchers have carefully evaluated motion films used for teaching and have reached the surprising conclusion that, even when the subject being taught has inherent motion, only about 45% of the motion shown is relevant. In other presentations, there is even less relevant motion. The rest is wasted footage. (McCluskey, 1925; O'Connor, 1942; Keisler, 1945; Irwin, 1950)

Perception of motion is manufactured in the brain. All presentation modes are equal--and really a series of stills, if we examined them carefully. However, it has been concluded that under some conditions, motion is an effective means of presenting cognitive information. To test for the conditions, Allen, Daehling, Russell, and Nielsen (1970) used seven different modes of testing. These included motion pictures, still pictures, print only, audio only, etc. They found that, in general, motion

is very effective. But, if they added audio, the advantage was wiped out. Sound related to still pictures appeared to be as effective as sound associated with motion.

Early evaluative studies were reported in detail in Allen (1960) and showed, in general, that still presentations were about as effective as motion pictures in teaching factual information. Other studies have found no differences in learning when instructed by motion or still pictures. Allen, Filep, and Cooney (1967), using motion pictures and still pictures to supplement prepared verbal instruction, found no differences between the two visual presentation modes. In a study on the audio implementation of still and motion pictures, Allen, Cooney, and Weintraub (1968) found no significant differences in performance under the two pictorial presentation conditions either for different mental ability level groups or when supplemented by different kinds of audio narration. In an unpublished study Fishell and Koch (date unpublished) compared sound motion pictures to three adapted sound filmstrips and found that there were no significant differences between the two modes.

Why should this be? Robert Travers theorized that channel switching might be the reason. Most contemporary books on audiovisual education take the position that learning will occur most effectively when both the auditory and the visual channels are being saturated with information. He is an advocate of the single-channel of perception. Time loss in channel switching can be observed when the information density is such that it has reached the limit of the capacity of the organism to handle (referenced on p. 21). This, of course, is a typical rather than an

exceptional state of affairs. The educational sound motion film can hardly be used economically unless it is transmitting information at a rate near the [illegible] at which information can be received by the learner. Under such conditions the loss of learning through channel switching becomes most evident. Travers says:

> This problem has not even been considered by the designers of those sound motion pictures which are to be used as teaching devices. From what has been learned ... there would appear to be much in favor of education motion pictures designed after the pattern of the old silent pictures which alternated print with visual displays.

Wells, Van Modfrans, Postlethwait, and Butler (1973) decided to test for: (1) Within a flexible system such as an audio-tutorial systems approach in which it is possible to present information via several media, are there general guidelines for selection of specific media to present specific concepts? (2) Are some media more easily adopted and adapted for use in an independent study format?

They studied the visual concepts involving the manipulation of time, space, and motion in both timed and untimed studies. The media tested were sequential still photographs, slides, and motion pictures. All three presentation modes were developed from the motion picture footage to ensure that all subjects would view materials containing identical information.

The advantages and disadvantages of using each medium were discussed by the researchers. Motion pictures were cited as requiring sophisticated equipment, being costly to develop, maintain, and replace, and, in general, a burden to time and budgets. It was also pointed out that motion pictures are inflexible, in that students must view them where and when projection

equipment is available, thus often making review impossible. Slides require preparation of multiple slide sets, making the cost nearly prohibitive. It was concluded that the same shortcomings of cost and flexibility noted for motion pictures were applicable to slides.

RESULTS

Concepts Involving Time:

The test scores were higher for students who viewed motion pictures than for those watching the two static displays. It was thought that this finding could have been the result of the particular slides and sequential stills used (either the number used or some other unexplained "peculiarity"), but the conclusion is that:

> It appears that concepts involving time are best presented with a medium which allows a continuous presentation (as perceived by the audience).

Concepts Involving Motion:

Since perception of motion, like perception of time, requires perception of a series of continuous events, the ability to detect motion requires a point of reference. Though a static instantaneous representation, such as a single slide or photographs, does not directly transmit information concerning the direction or speed of motion, it was hoped that the number of slides and photographs would be enough to ensure the point of reference necessary to recognize motion.

Wells, et al., found that the movie treatment was more effective than sequential still photographs in presenting concepts involving motion.

What was quite unexpected, however, was that slides were also more effective than sequential still photographs, while there was no significant difference between the effectiveness of motion pictures and slides.

Wells, et al., believe that one possible explanation may be that, in the case of sequential still photographs, the subject was required to move his eyes across the page, constantly changing his reference point. When viewing slides, the subject focused his eyes on one point while the slides changed, making the object's change of position in each succeeding slide more apparent. If the sequential still photographs had been presented in a flip-book format (like some comics of old) so that each succeeding image replaced the one that preceded it, a similar result might have been obtained.

As has been pointed out previously in this report (p. 28-29), Travers and Alvarado found that the addition of color seemed to help children recognize a dynamic, ongoing scene in still pictures. By use of other devices, such as arrows pointing in the direction of motion, blurring and extending lines away from the direction of movement, or depicting objects that are not in equilibrium, artists are able to transmit such information in single pictures. Travers also found that it was difficult to find textbook pictures depicting a static state, since most pictures depict some movement (boats moving, trees falling, lumberjacks swinging axes).

Concepts Involving Space:

The mean scores of the treatment groups suggested that slides and sequential still photographs were more effective than motion pictures for presenting concepts involving space.

Discussion of the reason for this finding included the following hypotheses. Space as involved in the concepts used in this experiment

remained constant. Also, where the aspects of space itself were of primary importance, motion was distracting. Therefore, they concluded that it was reasonable to consider static presentations more effective than motion pictures in presenting concepts involving space.

Wells, Van Modfrans, Postlethwait, and Butler had raised a second question in this study--i.e., whether certain media are better fitted for use in an independent study format. This is answered by the analysis of the data revealing no significant interaction between study format (timed and non-timed) and mode (movie, slide, stills). "The one exception was the mode-format interaction for the time spent studying the materials that included concepts involving time. The length of time required to present the slides in the timed format was fixed by the five-second timing of the projector. And much of the extra time required for the non-timed movie presentation can be accounted for by the time consumed operating the projector for review. Thus the significantly greater length of time required for these two combinations of mode and factor can be attributed to an artifact."

> There is no demonstrated superiority for any one form of media in an independent study format.

Bretz included this advice for the Armed Forces training groups, "The chances are very much against full motion being necessary. Since realistic representation is not relevant to abstract subject matter, natural motion is not needed. A still picture of a hand dropping a ballot into a ballot box may be a good symbol to use in expressing the idea of self-government."

Background Music:

The few studies which exist imply that music may actually distract the pupils from what they are expected to learn.

Size of Pictures:

Screen size, film or TV, seems to make no difference in learning if the viewer can see clearly what he is supposed to learn. Location of items within frames does seem to affect learning (Isaacs, 1969; Wolf, 1970).

Sex Differences in Visual Learning:

Dwyer (1970) reports that in general boys and girls learn equally well from identical types of visual illustrations when they are used to complement oral instruction. At high school level, the results indicate that there is no need to develop separate learning materials for students based on sex.

Mental Ability:

It is reported that there is no support for the idea that lower mental ability students learn more from pictorial than from verbal presentation. (Dwyer; Allen, Daehling, Russell, and Nielsen)

CHAPTER VI

Human Perception and Design of Materials

Fleming (1970) prepared an instructional designer's manual which incorporates perceptual principles as known today. His guidelines relate specific principles to specific action. Some of them are included in the following section.

GENERAL

1. Man's perception is relative rather than absolute.
   - A. Provide anchors or reference points to which perception can be related.
   - B. Pack the message relatively.
2. Man's perception is selective.
   - A. Limit the range of aspects presented.
   - B. Use pointers.
3. Man's perception is organized.
   - A. Make apparent the organization of messages.
   - B. Choose organizations consistent with concepts or subject matter.
4. Perception is variable, i.e., man perceives what he expects or is set to see and what his individual style and maturity and experience make more likely for him to perceive.

PERCEIVING BRIGHTNESS AND COLOR

Brightness, or intensity, and color are basic attributes of a message that are under the control of the designer.

> A change in stimulation is necessary for sustained sensitivity and normal functioning. (Berelson and Steiner)

An absolutely unchanging and homogeneous sensory field, be it overall light or dark or colored, becomes perceptually the same as nothing at all. Persons confined to such environments have difficulty sustaining perception, and tend to hallucinate.

Our sensory apparatus satiates, i.e., it becomes weary or fatigues under unchanging stimulus conditions.

> The amount of change in energy necessary to effect a just-noticeable difference varies directly with the initial amount of energy present. (Berelson and Steiner)

The lighter the initial shade of grey the greater the change in illumination will need to be in order for the change to be detectable.

> In general, the order of preference among Western people is: blue, red, green, purple, orange, yellow. (Vernon)

> Apparent brightness and color are influenced by adjacent brightness and color, and this adjacency can be either side-by-side in space or one-after-the-other in time. (Vernon)

PERCEIVING ELEMENTAL FEATURES

> Certain kinds of stimulus features, such as contours, are accentuated in perception, while others, such as uniform areas, are not. (Graham)

Physiological evidence suggests that contours and edges are one of the most "exciting" visual phenomena we encounter.

> Horizontal and vertical lines are perceptually more stable than lines at other orientations. (Forgus)

> An effective combination of iconic and digital signs appears to be a pictorial stimulus and a verbal response or label or description. (Use the visual/verbal order) (Gagne and Rohwer; Gropper)

We meet people and learn their names; we observe moisture forming on windows and hear the term condensation.

> An effective combination of digital signs is a more concrete work as stimulus and a less concrete work as response.(Paivio and Yarmey)

WORDS

We recognize words in reading without identifying all letters. Some of the features used are the redundancy of spelling patterns (random removal of letters, within limits, leaves intelligibility intact) and the overall shape of words (letters extending above and below the line, overall length). (Neisser)

Pictured objects (iconic signs) appear to be memorized more readily than their names (digital signs) presumably because of the greater number of perceptually available attributes.

PERCEPTUAL CAPACITY

> The greater the amount of processing (coding) required for certain information the less the capacity for that and other information, and vice versa, will be. (Maray)

There is some evidence that well-organized, readily coded material can be presented too slowly for perceptual and learning purposes, allowing students to perform unnecessary or erroneous recoding operations. (Neisser)

How much can a learner perceive and how much can he learn at one time?

> An individual can perceive at a glance up to about seven items (± 2). For familiar objects he can report some attributes about them: number, name, etc. (Miller)
>
> An individual can store in immediate memory up to about seven familiar items. (Miller)
>
> The perceiver partitions the available information into a large or as appropriate an item size as the stimulus and his experience and intention allow. He is said to chunk or cluster or group. (Miller)

The student who must learn 16 new words may, initially at least, seek ways of grouping them: alphabetically by first letters, by related meanings, by spatial arrays such as columns or lines.

> The better organized or patterned a message is perceived to be, the more information the observer can receive (and process) at one time and/or the better he will retain what is perceived. (Berelson and Steiner)

A string of nine digits is more difficult to learn than three strings (groups) of three digits, as the telephone company knows full well.

> The more familiar the message to its audience the more readily it is perceived. Thus, message familiarity increases capacity. (Berelson and Steiner, Vernon)

Reading rates vary directly with the familiarity of words and relations in the passage. Unfamiliar material takes longer, involves more reading.

SINGLE CHANNEL CAPACITY

> For verbal materials in a single channel situation, the visual channel (printed message) appears to have greater capacity than the auditory channel (spoken message). At least, it seems clear that the more difficult or complex the verbal material the greater the advantage of the visual channel over the auditory. (Severin)

TWO-CHANNEL CAPACITY

The two-channel research which has been most controversial for message designers has been that by Travers. On the basis of an extensive series of studies, he states the implications for designers as follows:

> "The evidence indicates that multiple sensory modality inputs are likely to be of value only when the rate of input of information is very slow .... The silent film with alternation of picture and print would appear to find much theoretical support as a teaching device."

The indication that multi-modal materials such as classroom films are frequently overloaded with information does seem highly probable. The fact that second showings of a film may increase learning by 35% is supporting evidence .... It seems probable that most instructional materials are informationally overloaded, a condition that becomes most acute where presentation is at a fixed pace.

Practically speaking, the channel overload can be seen to be of little consequence so long as the relevant portion of a message does not exceed capacity, and so long as the learner selectively perceives that relevant portion. (Hoban and Van Ormer)

SUMMARY

Estimates of single-channel capacity are still tentative. For words presented auditorially the estimates range up to 400 words per minute for a prose message (Travers). Much less is known about pictorial capacity though subjects can remember (recognize) with 90% accuracy over 2,500 pictures which have been presented at the rate of one every ten seconds (Haber).

The weaknesses of the auditory channel were noted, particularly for difficult material. The lessons for the designer are clear: shorter sentences for auditory material, more redundancy, and excellent technical quality.

Multiple-channel capacity has been a recent source of controversy among researchers. The case for simultaneous processing of information in two modalities or of two sign types is still to be unequivocally demonstrated, though motion picture and TV producers may be convinced that one can hear a track and see the action simultaneously. Of all the possible combinations of modality and sign, the one that appears to be most compatible and to permit the highest information load is the auditory modality (verbal sign) in combination with the visual modality (iconic sign), i.e., the slide and tape presentation, the film, television, the teacher talking while showing an overhead transparency, etc. Thus, employing separate modalities, each with differing signs, should permit the perceiver to select one or the other with minimum interference or, to a degree, simultaneously perceive both.

The three key perceptual principles considered are similarity, difference, proximity. Man groups similar things and separates different things. And the process is influenced by the spatial or temporal proximity of these things. Concepts are based on similarities, but learning to use them may depend heavily on the differences that distinguish one concept from another.

GUIDELINES FOR THE DESIGNER

Making the organizational outline of a message apparent (subtitles in a film or transitional statements in a speech) should improve perception and learning of its essential features.

Simultaneous presentation of several examples of a concept, such as drawings of various fungi, should be superior to one-at-a-time successive presentations.

Words imbedded in meaningful sentences should be more readily related and associated in memory than words presented outside of sentence contexts.

CHAPTER VII

What is the Best Medium to Use?

When Greenhill prepared a report on instructional films and instructional television, he made some cogent remarks. In testing for the best means of delivering material to students, it has been reported many times over that there is "no significant difference" between instructional films, television, and other test variables. He commented:

> While a finding of no significant differences does not prove that no differences exist, there is a practical value in such results in that consistent findings of nonsignificant differences in learning from different instructional methods give educational administrators some confidence that several alternative methods of instruction are available to use, and the choice of which should be used in a specific situation may be based on considerations other than relative effects of the methods on learning.

His argument continued for the choice of television for several reasons, two of which were:

- Television has excellent distributive powers.
- Television may offer courses that would otherwise be unavailable. Such courses may prove to be very satisfactory for the retraining of adults, especially in technical and professional fields.

Gross (1968) reviewed all the experimental research in educational television to that time and reported that it was obvious that television can teach. Schramm had looked over all the experiments comparing television teaching with conventional classroom teaching and found that more than 400 experiments had been conducted on that subject. Of that total, 65% reported no differences and 21% favored TV teaching.

There seems to be no difference between film and television presentation of the same material.

Some other findings are:

PRESCHOOL

- Structure is Important

Meichenbaum, Turk, and Rogers (1972) found that preschool tutorial programs which structured cognitive activities and emphasized self-instructional training were most effective for preschoolers.

Gerald Lesser is Chairman of the Advisory Committee, Children's Television Workshop, which produces Sesame Street. He has reported (1972, Schramm) the assumptions behind the production and writing methods of Sesame Street.

The research staff described observing these variations:

> Some children can view television for hours with their eyes rarely leaving the set. We were so struck by this viewing style when we first began doing research on appeal that we coined the term "zombie viewer" to refer to the child that sat, seemingly hypnotized, in front of the set. Other children constantly keep a check on all outside activities in the room while they view.

This last viewing pattern, in which a child seems able to watch television while simultaneously keeping track of other interesting events around him, has been described in other psychological research as "dual attention" and seems to characterize competent young children. "Zombie viewing" may reflect either intense concentration or stupor.

In addition to these patterns, another common viewing style displays overt, active physical and verbal participation in the television action.

- Children learn more when they respond actively during the program. (Gropper and Lumsdaine, 1961; Abbey, 1963)

Motivation

> There are probably some people in the world who work hard at various tasks because they have acquired an exotic taste for doing so. A heavy and persistent dose of the Puritan ethic may do that to you. But most children probably learn best what they want to learn, whether we think that it is good for them or not. Here is where television's non-punitiveness comes in. The child has nothing to fear when tuning in, no threat of humiliation, no possibility of disappointing others' expectations of him. If he does find it threatening or simply uninteresting, he can reduce it to personal oblivion. This principle of personal initiative in TV viewing, allowing a child full control over directing his own attention, seems crucial to children's learning, but is in sharp contrast to our hardy belief that children never do what is good for them unless they are forced to through some form of compulsion. Since we always have seen entertainment as competing with education, we have little experience in combining them to reinforce each other. (Lesser)

> All children watch much television at home. But bright children watch it less and less after their tenth birthday. Less intelligent children remain constant viewers until ages 12 or 13. (Pannitt)

Attention Directing

Young children pay greatest attention to:

- Animated films
- Cartoons
- Animated stills
- Introduction to novel subjects or objects
- Initiation of novel action by the teacher-performer

(Palmer, 1968)

Items which have been found to be most helpful in directing a child's attention by the research staff of Children's Television Workshop are:

- Incongruity
- Animation
- Action
- Humor
- Anticipation and Participation
- Diversity of Characters, Content, Style, and Pace

(See pages 114-160, Schramm, 1972, for complete report of these findings)

SCHOOL AGE

- Greater effort leads to greater retention and leads to greater enjoyment of the learning situation. (Buenz and Merril)
- Varying class size has no effect on learning.
- Teacher and parent interest seem to play a part in how much students learn.
- Elementary students are more favorable to TV than their high school counterparts. Attitude is based somewhat on subject matter.
- The preferable length of TV instruction is that to which people have been exposed.
- Viewers prefer programs that use other students on them.
- TV gives children the freedom to talk during broadcasts, some asking, some explaining answers to questions.

- Without coordination between the video and the audio, one will act as a distractor of the other. (Imagine learning Chinese characters through pictures and Russian through the audio channel at the same time.)

Programming

- Since programming has a powerful effect on the programmer, if not on the student, it appears that teachers should write programs. (Cohen)
- An apparently useful technique in revising programs is on the basis of what students did not learn from them. An apparently unsatisfactory method for improving programs is to show television teachers their lessons.

Teachers

- Good teaching is the same on television, film, or the lecture platform. (Schramm)
- Teachers are often hostile until they have had the opportunity to participate in TV and then their attitude becomes more favorable.
- Television programs regarded as direct communication with the students, not for optional use by a teacher as an "illustration," are more successful. The teachers then regard them as "show" for students, not "model lessons" by a "super teacher," which is non-threatening. (Ely in Schramm, ed., 1972)

Planning and Usage

- Planning must be done more than a month in advance for film. For television, most teachers plan in advance about a week.
- Teachers will choose to use television when it is available to them over other forms of media.
- A set available in the teaching room results in use of television programs about 1 1/2 times per day. (If sets are available but not in the room, 70% of the teachers use TV less than once a month.) (Dobosh and Wright)

ADULT EDUCATION

- There is no significant difference between viewing programs at home versus in a classroom. However, Abbey (1963) working with nurses who watched a program, found that those who watched at home did significantly better than those watching in a group at a hospital. Merrill reported, "When training nurses by broadcast TV, those viewing at home learned significantly more than those viewing in a group in a classroom. This means that we can direct professional education of all kinds to home viewing." McIntyre has reported, "At the University of Illinois, we taught televised courses where election of where to view was left up to students. Half chose classrooms; half the residence halls or elsewhere. There is no practical effect on student achievement."

GENERAL

- Arthur C. Clarke has stated, "The hypnotic effect of a screen may be necessary, even when the essential information is going to a person's ears."

- A restatement of Lesser's comments on motivation might say: Allowing a person full control over his own attention seems crucial to learning.

CHAPTER VIII

What Research Tells Equipment Designers

"To live effectively is to live with adequate information."
(Nobert Weiner)

We have examined what multi-discipline researchers have told us about how the human brain functions. Now, let us define a system incorporating the knowns into a single whole, which we will call "integrated." The learner comes to a point which requires him to "discover" something which is new to him. How can he best get the information which is required to advance? What do we need which will fulfill the requirements of all prospective learners--preschool, school age, or adult? The researchers have structured that, too.

- Television is the most universal of all the media in that it can transmit and receive more kinds of information than any other. Television already is primarily a means of transmitting films and video tape recordings. Transmission of information from the store to the requesting learner will be required. We have seen that television is a carrier, or transmission system.

- Several studies have been noted which indicate that instructional films and instructional television make very little use of motion. It is estimated that a still-TV media would be able to convey over 80% of the material which we now convey via full television (some estimates range up to 95%). (Bretz)

When at least one completely justifiable use for television calls on its full potentials--sound, print, picture, motion, and the immediacy of live transmission--television can be applied successfully as a universal instructional medium. Under such conditions, a television system can (also) be utilized for any telecommunication purposes, in full or partial modes, audio only, still pictures only, or simply as a transmission medium to distribute recorded materials. (Bretz)

- When there are specific needs, which will not have to be replicated often, how much effort should go into production of materials? A local answer to a local problem may be best. Here is why:

  1. Local production can respond quickly to local need.
  2. Local production can be highly specific--tailored to particular needs.
  3. Local production can be rapidly evaluated in practice and rapidly revised.
  4. Locally produced materials tend to be better used.

  (Bretz)

- It would seem that active participation by the student is required--in selection of materials and relative to it. We have seen that when the student actively participates he learns more and remembers longer.

- It is believed that the limited storage capacity of the human mind requires some kind of external storage of materials. With the massive amounts of information to be stored (or libraried) today and the rapidity of change in the materials, we have neither the room nor the interest in storing all known materials on a given subject at a local level. However, material on any

topic must be available at some easily reached location. Do we have to physically go to that location, or could we perhaps have it sent out?

Therefore, we have several things which we would like to combine:

- Storage of all materials at central locations.
- Delivery (retrieval) of specific information to a learner when he wants and needs it.
- A "universal" medium for reception of the material, including both the audio and visuals.
- A means for local production of materials which are of unique interest to that location.
- Means of entering up-dated materials in the central stores.

C. Ray Carpenter has defined such a system requirement thus:

> The extreme of mass instruction and individualization of instruction alone need not be used. All learning is individual, but the conditions of learning can be varied in terms of group size. The operational principle is to move information and learning materials to the people and reduce as much as possible the travel of people to the places where learning materials originate or are displayed. (The right size technology) is that size and complexity which are necessary to serve well the essential education-learning functions without excess or waste of resources.
>
> (Schramm, ed., 1972)

Use of the television set (receiver) is a practical means of delivering constantly updated audio and visual information to a learner. Remaining is the problem that television programs today are scheduled, which precludes ready access to information of a special nature for a few requestors, and the problem of the amount of time eaten up with a regularly-scheduled

broadcast. Therefore, the problem to be solved is delivery within a reasonable time of any requested information, compact storage of materials at a central location where constant up-dating can take place, and active participation by the student so that material viewed and heard is retained.

VOLUME II

BIBLIOGRAPHY

* Recommended Reading

The entries cited with an asterisk are those which will provide an adequate overview of the literature and theories presented in this paper and are deemed to be of general interest.

This in no way implies that other citations may not be as valuable in content.

BIBLIOGRAPHY

Abbey, June C., et. al., Home and Hospital Viewing of Continuing Education Broadcasts Under Three Presentation-Response Conditions, USOE Project No. 164, San Francisco: University of California, San Francisco Medical Center, September 30, 1963.

Allen, Leigh, "Eleven Cameras for Circarama," American Cinematographer, Vol. XXXVI, August, 1955, p. 476.

Allen, W. H., A Course of Study and Bibliography for Instruction in Educational Media Research and Theory, Final Report, (HEW, OE, Bureau of Research, Bureau No. B-236-A, Contract No. OEC-3-16-021), March, 1969.

Allen, W. H., S. M. Cooney, and R. Weintraub, Audio Implementation of Still and Motion Pictures, NDEA Title VII, Project No. 5-0741, Los Angeles: Research Division, Department of Cinema, University of Southern California, April 16, 1968.

Allen, W. H., "Audio-Visual Communication," Encyclopedia of Educational Research, edited by Chester W. Harris, 3rd ed., New York: MacMillian, 1960, pp. 115-137.

*Allen, W. H., ed., Readings in Educational Media Theory and Research, Final Report, (HEW, OE, Bureau of Research, Bureau No. B-236-A, Contract No. IEC-3-16-021), (ED 031952, ED 031953, ED 031956), Volumes I, II, III, August, 1968.

*Allen, W. H., W. A. Daehling, J. J. Russel, IV, T. G. Nielsen, Effectiveness of Different Combinations of Visual and Verbal Presentation Modes in Teaching Different Kinds of Learning Tasks, Washington, D.C.: U. S. Department of Health, Education, and Welfare, Office of Education, Bureau of Research (Project No. 6-1265, Grant No. OEG-1-7-061265-3506), (ED 044759), September, 1970.

Allen, W. H., "Effectiveness of Instructional Films," Audio-Visual Communication Research, Santa Monica, California: System Development Corporation, September 20, 1958, pp. 9-13.

Allen, W. H., "Media Stimulus and Types of Learning," Audio-Visual Instruction, Vol. 12, January, 1967, pp. 27-31.

Allen, W. H., "Readability of Instructional Film Commentary," Journal of Applied Psychology, Vol. 36, 1952, pp. 164-168.

Allen, W. H., "Research on Film Use: Student Participation," AV Communication Review, Vol. 5, 1957, pp. 423-450.

Allen, W. H., and S. M. Cooney, A Study of the Non-Linearity Variable in Filmic Presentation, Los Angeles: Research Division, Department of Cinema, University of Southern California, May, 1963.

Allen, W. H., R. F. Filep, and S. M. Cooney, Visual and Audio Presentation in Machine Programed Instruction, U. S. Office of Education, Cooperative Research Project No. 5-0724-2-12-1, Los Angeles: Research Division, Department of Cinema, University of Southern California, January, 1967.

Allen, W. H., and R. Weintraub, The Motion Variable in Film Presentation, NDEA Title VII, Project No. 5-1123, Los Angeles: Research Division, Department of Cinema, University of Southern California, December, 1968.

Angell, G. W., "Effect of Immediate Knowledge of Quiz Results on Final Examination Scores in Freshman Chemistry," Journal of Educational Research, Vol. 42, 1949, pp. 391-394.

"Approach to Multi-Imagery," Business Screen Magazine, Vol. XXIII, 1962, pp. 36-39.

Arkadyev, B., "Multi-Screen," Soviet Screen, October, 1969, p. 14.

Arnheim, Rudolf, Art and Visual Perception, Berkeley: University of California Press, 1954.

Ash, P., "The Relative Effectiveness of Massed Versus Spaced Film Presentation," Journal of Educational Psychology, Vol. 14, 1950, pp. 19-30.

Ash, P., and N. Jaspen, The Effects and Interactions of Rate of Development, Repetition, Participation, and Room Illumination on Learning From a Rear Projected Film, (Technical Report SFD 269-7-39), Instructional Film Research Reports, Port Washington, Long Island, New York: U. S. Naval Special Devices Center, 1953.

Asher, J. J., and R. I. Evans, "An Investigation of Some Aspects of the Social Psychological Impact of an Educational Television Program," Journal of Applied Psychology, Vol. 43, 1959, pp. 166-169.

Attneave, Fred, Applications of Information Theory to Psychology, New York: Henry Holt and Co., 1959.

Attneave, Fred, "Some Informational Aspects of Visual Perception," Psychological Review, Vol. LXI, May, 1954, pp. 183-193.

Aylward, T. L., Jr., "A Study of the Effects of Production Technique on a Televised Lecture," Dissertation Abstracts, Vol. 21, 1960, pp. 1660-1661.

Baker, E. J., and E. A. Alluisi, "Information Handling Aspect of Visual and Auditory Form Perception," Journal of Engineering Psychology, Vol. I, 1962, pp. 159-179.

Ball, Samuel, and others, The First Year of "Sesame Street": An Evaluation, Final Report, Princeton, New Jersey: Educational Testing Service, Vol. III of five volumes, October, 1970.

Barlow, H. B., "Principles Underlying the Transportation of Sensory Messages," Sensory Communication, W. A. Rosenblith (ed.), New York: Wiley, 1961, pp. 217-234.

Barlow, H. B., "Sensory Mechanisms: The Reduction of Redundancy and Intelligence," Mechanization of Thought Processes, National Physical Laboratory, Symposium No. 10, London: Her Majesty's Stationery Office, Vol. 2, 1959, pp. 535-574.

Barrow, L. C., and B. H. Westley, "Exploring the News: An Experiment on the Relative Effectiveness of Radio and TV Versions of a Children's News Program," AV Communication Review, Vol. VII, 1959, pp. 14-23.

Bart, Leonard E., A Comparison of the Effectiveness of Televised and Conventional Administrations of Objective Scales, Jamaica, New York: St. John's University, Dissertation Abstracts International, Vol. 32, No. 5-B, November, 1971, pp. 2980-2981.

Battig, William F., "Evidence for Coding Processes in 'Rote' Paired Associate Learning," Journal of Verbal Learning and Verbal Behavior, Vol. 5, 1966, pp. 177-181.

Beebe-Center, J. G., M. A. Rogers, and D. N. O'Connel, "Transmission of Information About Sucrose and Saline Solutions Through the Sense of Taste," Journal of Psychology, Vol. XXIX, 1955, pp. 157-160.

Behan, R. A., C. R. Bugham, J. N. Bumpus, and S. Gilbert, "An Experimental Investigation of the Interaction Between Problem Load and Level of Training," Human Factors, Vol. III, 1961, pp. 53-59.

Beirschenk, B., Television as a Technical Aid in Education and in Educational and Psychological Research: A Bibliography, Malmo (Sweden): School of Education, Department of Educational and Psychological Research, Report No. R-24, November, 1969.

Beisenherz, P. C., "What Instructional TV Research Says to the Researcher," paper presented at the annual meeting of the Mid-South Educational Research Association (first, New Orleans, Louisiana, November 10, 1972).

Berelson, Bernard, Gary A. Steiner, "Perceiving," Human Behavior, An Inventory of Scientific Findings, Harcourt, Brace and World, Inc. New York, 1964.

Berlyne, D. E., "The Influence of Complexity and Novelty in Visual Stimuli on Orienting Responses," Journal of Experimental Psychology, Vol. LV, 1958, pp. 289-296.

Bern, H. A., "Learning and Physiological Responses to Various Word-Picture Combinations," unpublished doctoral dissertation, Bloomington, Indiana University, 1958.

Birren, F., "The Effects of Color on the Human Organism," American Journal of Occupational Therapy, Vol. 13, 1959, pp. 125-129.

Blain, B. B., "Effects of Film Narration Type and of Listenability Level of Learning of Factual Information," AV Communication Review, Vol. 4, 1956, pp. 163-164.

Blancheri, R. L., and I. R. Merrill, "The Step Presentation of Dental Technic Instruction," Television in Health Sciences Education, USOE Project 064, San Francisco: University of California, San Francisco Medical Center, September, 1963, pp. 34-37.

Bloom, B. S., "Learning for Mastery," Evaluation Comment of UCLA Center for the Study of Instructional Programs, May, 1968, 1(2).

Bloom, B. S. (ed.), Taxonomy of Educational Objectives: The Classification of Educational Goals: Handbook I: Cognitive Domain, New York: Longmans, Green, and Co., 1956.

Bourcier, A., A. Gothier, B. Gueritte, R. Mucchielli, and G. Vaux, "Le Bon Depart," Information Psychologue, Vol. XII, 1963, pp. 1-72.

Bourne, L. E., and F. Restle, "Mathematical Theory of Concept Identification," Psychological Review, Vol. 66, 1969, pp. 278-296.

Bower, Gordon H., Mental Imagery and Memory, Colloquium speech delivered to several psychology departments during May, 1967.

Bower, Gordon H., Michael C. Clark, Alan M. Lesgold, and David Winzenz, "Hierarchical Retrieval Schemes in Recall of Categorized Word Lists," Journal of Verbal Learning and Verbal Behavior, Vol. 8, 1969, pp. 323-343.

Boynton, Robert M., "The Psychophysics of Vision," in Ralph N. Haber, ed., Contemporary Theory and Research in Visual Perception, Holt, Rinehart, and Winston, Inc., New York, 1968.

Brandon, J. R., "The Relative Effectiveness of Lecture, Interview, and Discussion Methods of Presenting Factual Information by Television," Speech Monographs, 1956, pp. 23, 118.

Bretz, Rudy, Color Television in Instruction, Santa Monica, California: Rand Corporation, Research Report No. P-4402, 1970.

*Bretz, Rudy, Communication Media: Properties and Uses, Santa Monica, California: Rand Corporation, Memorandum RM-6070-NLM/PR, 1969.

Bretz, Rudy, Multi-Image Films at Expo '70: A Trip Report, Santa Monica, California: Rand Corporation, P-4499, 1970.

*Bretz, Rudy, The Selection of Appropriate Communication Media for Instruction: A Guide for Designers of Air Force Technical Training Programs, Santa Monica, California: Rand Corporation, R-601-PR, 1971.

Briggs, L. J., Handbook of Procedures for the Design of Instruction, Pittsburgh, Pennsylvania, American Institutes for Research, 1970.

Briggs, L. J., Sequencing of Instruction in Relation to Hierarchies of Competence, Pittsburgh, Pa., American Institutes for Research, 1968.

Briggs, L. J., P. O. Campeau, R. M. Gagne, and M. A. May, Instructional Media: A Procedure for the Design of Multi-Media Instruction, a Critical View of Research, and Suggestions for Future Research, a final report to the U. S. Office of Education, Pittsburgh: American Institutes for Research, 1967.

Broadbent, D. E., "Information Processing in the Nervous System, Science, Vol. 150, 1965, pp. 457-462.

Broadbent, D. E., "Successive Responses to Simultaneous Stimuli," Quarterly Journal of Experimental Psychology, Vol. 8, 1956, pp. 145-152.

Broadbent, D. E., Perception and Communication, New York: Pergamon, 1958.

Brown, J., "Information and Decay of the Memory Trace," Mechanization of Thought Process, Symposium No. 10, London: Her Majesty's Stationery Office, Vol. 2, 1959, pp. 729-746.

Brown, L., Television: The Business Behind the Box, New York: Harcourt Brace Jovanovich, 1972.

Bruner, J. S., "On Perceptual Readiness," Psychological Review, Vol. LXIV, 1957, pp. 123-152.

Bruner, Jerome S., The Process of Education, Harvard University Press, Cambridge, 1960.

Bruner, J. S., J. S. Goodnow, and G. A. Austin, A Study of Thinking, New York: Wiley, 1956.

Budoff, M., and D. Quinlin, "Reading Progress as Related to Efficiency of Visual and Aural Learning in the Primary Grades," Journal of Educational Psychology, Vol. LV, 1964, pp. 247-255.

Buenz, R. Y., and I. R. Merrill, "Effects of Effort on Retention and Enjoyment," Journal of Educational Psychology, Vol. 59, No. 3, 1968, pp. 154-158.

Bulgarella, R. G., and E. J. Archer, "Concept Identification of Auditory Stimuli as a function of Amount of Relevant and Irrelevant Information," Journal of Experimental Psychology, Vol. 63, 1962, pp. 254-257.

Burke Marketing Research, Inc., Burke Color Study, Cleveland: AVCO Broadcasting Corporation, 1960.

Buschke, H., "Auditory and Visual Interaction in Immediate Memory," Journal of Psychiatric Research, Vol. I, 1962, pp. 229-237.

Busignies, Henri, "Communication Channels," Scientific American, Vol. 227, No. 3, September, 1972, pp. 98-115.

Calkins, M. W., "Short Studies in Memory and in Association from the Wellesley College Psychology Laboratory," Psychological Review, Vol. V, 1898, pp. 451-462.

Cantor, G. N., "Effects of Three Types of Pretraining on Discrimination Learning in Preschool Children," Journal of Experimental Psychology, Vol. XLI, 1955, pp. 339-342.

Caputo, D. V., and W. Mandell, "Consequence of Low Birth Weight," Developmental Psychology, Vol. 3, Pt. 1, Nov. 1970, pp. 363-383.

Carlson, H. B., and H. A. Carr, "Visual and Vocal Recognition Memory," Journal of Experimental Psychology, Vol. XXIII, 1938, pp. 523-530.

Carpenter, C. R., "A Theoretical Orientation for Instructional Film Research," AV Communication Review, Vol. I, 1953, pp. 38-52.

Carpenter, C. R., and L. P. Greenhill, Instructional Television Research, Report No. 2, University Park, Pennsylvania: Pennsylvania State University, 1958.

Carterette, E. C., and M. H. Jones, "Visual and Auditory Information Processing in Children and Adults," Science, Vol. CLVI, 1967, pp. 986-988.

Carver, M. E., "Listening Versus Reading," The Psychology of Radio, edited by H. Cantrill and G. W. Allport, New York: Peter Smith, 1941, pp. 159-180.

Cautela, J. R., "The Effect of Drive on Probability Learning," Journal of Psychology, Vol. LIX, 1965, pp. 67-71.

Cautela, J. R., "Probability Learning and Intelligence," Psychology, Vol. II, 1965, pp. 40-43.

Cazden, Courtney B., "Language in Early Childhood and Reading: A Review for 1969/70," Center for Applied Linguistics, Washington, D.C., ERIC Clearinghouse for Linguistics, sponsoring agency, New York: Ford Foundation, May, 1970.

Chall, J. S., and H. E. Dial, "Predicting Listener Understanding and Interest in Newscasts," Educational Research Bulletin, Vol. 27, 1948, pp. 141-153.

Chambers, R. W., and N. R. Bartlett, "A Device for Research in Human Information Processing Capacity," Perceptual & Motor Skills, Vol. XV, 1962, pp. 343-350.

Chan, A., R. M. W. Travers, and A. P. Van Mondfrans, AV Communication Review, Vol. 13, 1965, pp. 159-164.

Cheatam, P. G., A Comparison of the Visual and Auditory Senses as Possible Channels for Communication, Air Materiel Command, U. S. Air Force Technical Report 5919 (PB 110278), 1950.

Cherry, C., On Human Communications: A Review, a Survey, and a Criticism, New York: John Wiley, 1957 (Science ed., 1961).

Cherry, C. E., "Some Experiments on the Recognition of Speech With One and Two Ears," Journal of the Acoustical Society of America, Vol. XXV September, 1953, pp. 975-979.

Cherry, C., "The Band Width Compression of Television and Facsimile," The Television Society Journal, Vol. X, 1962, pp. 40-49.

*Chu, G., and W. Schramm, Learning from Television: What the Research Says, Washington: National Association of Educational Broadcasters, 1967.

Cincinnati Public School, Ohio, Five Years of Research in Television Instruction in the Cincinnati Public Schools, 1955-56 through 1959-60, September, 1960.

Cleff, S. H., "Post Conditioning Labeling and the Stimulus Generalization Gradient," unpublished PhD dissertation, University of Pennsylvania, 1958.

Cogswell, J. F., Effects of a Stereoscopic Sound Motion Picture on the Learning of a Perceptual Motor Task, (Technical Report, SDC 269-7-32), Port Washington, New York: U. S. Naval Special Devices Center, 1952.

Cohen, D., "The Impact of Television on Science Education," Australian Science Teachers Journal, Vol. 16, No. 2, August, 1970, p. 7-15.

Cohen, W. M., Multi-Media Instructional Program, washington, D.C.: American Association of Junior Colleges, January, 1969.

Cole, M., "Search Behavior: A Correction Procedure for Three-Choice Probability Learning," Journal of Mathematical Psychology, Vol. II, 1965, pp. 145-170.

Cole, M. J. Gay, J. Glock, and D. W. Sharp, The Cultural Context of Learning and Thinking, New York: Basic Books, 1971.

Collins, W. A., "Learning of Media Content: A Developmental Study," Child Development, Vol. 41, 1970, pp. 1133-1142.

Committee on Science and Astronautics, The Management of Information and Knowledge, Washington, D. C.: U. S. House of Representatives, 1970.

Connell, D. D., and E. P. Palmer, "Cooperation Between Broadcasters and Researchers," Leicester, England: International Seminar on Broadcaster/Researcher Cooperation in Mass Communication Research, 1970.

Connolly, C. P., Jr., "An Experimental Investigation of Eye-Contact on Television," M. A. Thesis, Ohio University, Athens, Ohio, 1962.

Conway, J. K., "Channel Versus Modality," excerpted from "Multiple-Sensory Modality Communication and the Problem of Sign Types," AV Communication Review, Vol. XV, 1967, pp. 371-383.

Conway, J. K., "Information Presentation, Information Processing, and the Sign Vehicle," AV Communication Review, Vol. 16, No. 4, 1968, pp. 403-414.

Conway, J. K., "Multiple-Sensory Modality Communication and the Problem of Sign Types," AV Communication Review, Vol. 15, No. 4, 1967, pp. 371-383.

Conway, M. J., "Development of Auditory and Visual Memory," Archives of Psychology, Vol. XI, 1909, pp. 4-8.

Cook, J. O., "Research in Audio-Visual Communication," in J. Ball and F. C. Byrnes (eds.), Research, Principles, and Practices in Visual Communication, East Lansing: Michigan State University, National Project in Agricultural Communications, 1960, pp. 91-106.

Cooney, S. M., "Nonlinearity in Filming Presentation," AV Communication Review, Vol. XII, Fall, 1964, pp. 302-324.

Corey, S. M., "Learning from Lectures Versus Learning from Readings," Journal of Educational Psychology, Vol. XXV, 1934, pp. 459-470.

Crai[illegible], G., "A Comparison Between Sound and Silent Films in Teaching," British Journal of Educational Psychology, Vol. 26, 1956, pp. 202-206.

Creamer, L. R., "Event Uncertainty, Psychological Refractory Period, and Human Data Processing," Journal of Experimental Psychology, Vol. LXVI, 1963, pp. 187-194.

D'Ambrot, F., "General Psychology Over Closed-Circuit Television: A Decade of Experience With 20,000 Students," AV Communication Review, Vol. 20, No. 2, Summer, 1972, pp. 181-193.

Day, H. I., and D. Berlyne, "Intrinsic Maturation," in G. S. Lesser (ed.), Psychology and Educational Practice, Glenview, Illinois: Scott Foresman, 1971, pp. 294-335.

Day, W. F., and B. R. Beach, A Survey of the Research Literature Comparing the Visual and Auditory Presentation of Information, Air Force Technical Report 5921 (PB-102410), Charlottesville: University of Virginia, 1950.

Davis, R., "The Human Operator as a Single Channel Information System," Journal of Experimental Psychology, Vol. IX, 1957, pp. 110-129.

DeCecco, John P., The Psychology of Learning and Instruction: Educational Psychology, Prentice-Hall, Inc., Englewood Cliffs, New Jersey, 1968.

Decker, M. G., "The Differential Effects Upon the Learning of the Natural Sciences by Fifth Graders of Two Modes of Teaching Over Television and in the Classroom," Boston, Mass.: Boston University School of Education, 1965.

DeSoto, Clinton B., Marvin London, and Stephen Handel, "Reasoning and Spatial Representations," Journal of Verbal Learning and Verbal Behavior, Vol. 7, 1968, pp. 351-357.

Deutsch, C., "Auditory Discrimination and Learning: Social Factors," Merrill-Palmer Quarterly, Vol. 10, 1964, pp. 277-296.

Deutschmann, P. J., L. C. Barrow, Jr., and A. McMillan, "Efficiency of Different Modes of Communication," AV Communication Review, Vol. 9 1961, pp. 263-270.

DeValois, R. L., "Neural Processing of Visual Information," in R. M. Russell (ed.) Frontiers in Physiological Psychology, Academic Press, New York, 1966, pp. 51-91.

Diamond, R. M., "The Effect of Closed Circuit Resource Television Upon Achievement in the Laboratory Phase of a Functional Anatomy Course: A Comprehensive Investigation of Television as a Magnification Device During Laboratory Demonstrations," Dissertation Abstracts, Vol. 23, 1962, p. 884.

Diehl, C. F., R. C. White, and K. W. Burk, "Rate and Communication," Speech Monographs, Vol. 26, 1959, pp. 299-232.

Dietmeyer, H. J., A. C. Sneehan, and M. Decker, An Investigation of Concept Development in Elementary School Science Teaching by Television, NDEA Title VII Project No. 527, Boston: Boston University, 1963.

Dixon, W. J. (ed.), Biomedical Computer Programs, Los Angeles: University of California, 1968.

Dobbing, J., J. W. Hopewell, and A. Lynch, "Vulnerability of Developing Brain: VII. Permanent Deficit of Neurons in Cerebral and Cerebellar Cortex Following Early Mild Undernutrition," Experimental Neurology, Vol. 32, No. 3, September, 1971, pp. 439-447.

Dobbing, J., "Undernutrition and the Developing Brain: The Use of Animal Models to Elucidate the Human Problem," Psychiatria, Neurologic, Neurochirurgia, Vol. 74, No. 6, 1971, pp. 433-442.

*Dobosh, O., and E. N. Wright, Television Utilization, Toronto, Ontario, Canada: The Board of Education for the City of Toronto, Research Department, 1971 (#111).

Dubin, R., and others, The Medium May be Related to the Messages: College Instruction by TV, Eugene, Oregon, Oregon University Center for Advanced Study of Educational Administration, DHEW, OE, Bureau of Research, Bureau No. BR 5-0217, Contract OEC-4-10-163, 1969.

Duke, B., and M. Nishimoto, Survey of Educational Media Research and Programs in Asia, Report to U. S. Office of Education, Washington, D. C., 1963.

Duncan, D. B., "Multiple Range and Multiple F Tests," Biometrics, Vol. 11, 1965, pp. 1-42.

Dunn, Barbara J., "The Effectiveness of Teaching Selected Reading Skills to Children Two Through Four Years of Age by Television," Los Angeles: University of California, 1970.

Durrell, D., and H. Murphy, "The Auditory Discrimination Factor in Reading Readiness and Reading Ability," Education, Vol. LXXII, 1953, pp. 556-560.

Duva, J. S., and A. A. Lumsdaine, "The Influence of Image Quality on the Teaching Effectiveness of the Kinescope," U. S. Air Force, Human Factors Operations Research Laboratories, unpublished HFORL report, March, 1956, summarized in Lumsdaine, 1963.

Dwyer, F. M., A Study of the Relative Effectiveness of Varied Visual Illustrations, final report, U. S. Department of Health, Education, and Welfare, Project No. 6-8840, University Division of Instructional Services, the Pennsylvania State University, 1967.

Dwyer, F. M., "Adapting Varied Visual Illustrations for Optimum Teaching and Learning," Medical and Biological Illustration, Vol. 21, No. 1, 1971, pp. 10-13.

*Dwyer, F. M., "An Analysis of the Instructional Effectiveness of Visual Illustrations Presented Via Television," Journal of Psychology, Vol. 72, 1969, pp. 61-64.

*Dwyer, F. M., "An Experimental Evaluation of the Instructional Effectiveness of Black and White and Colored Illustrations," Didakta Medica, Vol. 3 and 4, 1971, pp. 96-101.

Dwyer, F. M., An Experimental Evaluation of Visual Illustrations Used to Complement Programmed Instruction, University Division of Instructional Services, the Pennsylvania State University, University Park, Pa., 1967.

Dwyer, F. M., An Experimental Study of the Use of Visual Illustrations Used to Complement Oral Instruction on Television, University Division of Instructional Services, the Pennsylvania State University, University Park, Pa., 1968.

*Dwyer, F. M., "Color as an Instructional Variable," AV Communication Review, Vol. 19, Winter, 1971, pp. 399-416.

Dwyer, F. M., "Effect of Visual Stimuli on Varied Learning Objectives," Perception and Motor Skills, Vol. 27, 1968, pp. 1067-1070.

Dwyer, F. M., "Effect of Varying Amount of Realistic Detail in Visual Illustrations Designed to Complement Programmed Instruction," Perceptual and Motor Skills, Vol. 27, 1968, pp. 351-354.

*Dwyer, F. M., "The Effect of Stimulus Variability on Immediate and Delayed Retention," Journal of Experimental Education, Vol. 38, 1969, pp. 30-37.

Dwyer, F. M., "An Experiment in Visual Communication," Journal of Research in Science Testing, Vol. 37, 1969, pp. 67-75.

Dwyer, F. M., "Exploratory Studies in the Effectiveness of Visual Illustrations," AV Communication Review, Vol. 18, 1970, pp. 235-249.

*Dwyer, F. M., "Student Perceptions of the Instructional Effectiveness of Black and White and Colored Illustrations," Journal of Experimental Education, Vol. 40, Fall, 1971, pp. 28-34.

Dwyer, F. M., Visual Learning: An Analysis by Sex and Grade Level, University Division of Instructional Services, the Pennsylvania State University, University Park, Pa., April, 1970.

Egorov, V. A., "Operator's Channel Capacity as an Indicator of Degree of Learning and Task Complexity," Voprosy Psikhologii, Vol. I, 1965, pp. 2-8.

Elkind, D., R. Koegler, and E. Go, "Studies in Perceptual Development: II, Part Whole Perception," Child Development, 1964.

Ellery, J. B., A Pilot Study of the Nature of Aesthetic Experiences Associated with Television and Its Place in Education, Detroit: Wayne State University, January 15, 1959.

Ely, D. P., Survey of Educational Media Research and Programs in Latin America, report to the U. S. Office of Education, Washington, U. S. Office of Education, 1963.

Eriksen, C. W., and H. W. Hake, Absolute Judgment as a Function of the Stimulus Range and the Number of Stimulus and Response Categories, USAF WADC TR, April, 1954 (also in Journal of Experimental Psychology, 1955, pp. 323-332).

Eriksen, C. W., and E. W. Hake, Multidimensional Stimulus Differences and Accuracy of Discrimination, USAF WADC TR, 1951, pp. 54-165, (also in Journal of Experimental Psychology, 1955, pp. 153-160.

Fairbanks, G., W. H. Everitt, and R. P. Jaeger, "Method for Time of Frequency Compression-Expansion of Speech," Transactions of the Institute of Radio Engineers, Professional Group on Acoustics, 1954.

Faison, E. W. J., N. Rose, and J. F. A. Podell, A Technique for Measuring Observable Audience Reactions to Training Films, Air Force Personnel and Training Research Center, Training Aids Research Laboratory, Note TARL-LN-55-45, summary in Lumsdaine, 1961 and 1963.

Feigenbaum, E. A., and H. A. Simon, "Brief Notes on the EPAM Theory of Verbal Learning," in C. N. Cofer and Barbara S. Musgrave (eds.) Verbal Behavior and Learning, New York: McGraw-Hill Book Co., 1963, pp. 333-335.

Felicianao, G. D., R. D. Powers, B. E. Kearl, "Graphic Presentation," AV Communication Review, Vol. XI, May-June, 1963, pp. 32-39.

Fishell, K. N., and C. M. Koch, A Comparative Study of Student Achievement Using Selected Instructional Motion Pictures with Reduced Visual Information Load, paper presented at the Department of Audiovisual Instruction Convention, Portland, Oregon, April, 1969.

Fleming, Malcolm L., Message Design: The Temporal Dimension of Message Structure, USOE Final Report, NDEA Title VII Project 1401, March, 1968.

*Fleming, Malcolm L., Perceptional Principles for the Design of Instructional Materials, Bloomington, Indiana: Indiana University, Audio-Visual Center, U. S. Department of Health, Education, and Welfare, Office of Education, Bureau of Research, Project No. 9-E-001, Grant No. OEG-5-9-245001-0016 (ED 037093), January, 1970.

Fordham University, Training by Television: The Comparative Effectiveness of Instruction by Television, Television Recordings, and Conventional Classroom Procedures, (Technical SDC 476-02-2) Port Washington, New York: U. S. Naval Special Devices Center, 1953.

Forgus, Ronald H., Perception, McGraw-Hill Book Company, New York, 1966.

Foulke, Emerson, Procedings of the Louisville Conference on Time Compressed Speech, October 19-21, 1966, Center for Rate Controlled Recording, University of Louisville, Louisville, Kentucky.

Freeman, J., and C. O. Neidt, "Effect of Familiar Background Music Upon Film Learning," Journal of Educational Research, Vol. 53, 1969, pp. 91-96.

French, J. E., "Children's Preferences for Pictures of Varied Complexity of Pictorial Pattern," Elementary School Journal, October, 1952, pp. 90-95.

Frey, Christer, The Effect of Colour on Learning by Television, Stockholm: Sveriges Radio, N.D. (1970?).

Fullerton, B. J., "The Comparative Effect of Color and Black and White Guidance Films Employed With and Without 'Anticipatory' Remarks Upon Acquisition and Retention of Factual Information," Dissertation Abstracts, 1956, Vol. 16, p. 1413.

Gage, N. L., "An Analytical Approach to Research on Instructional Methods," Phi Delta Kappan, Vol. 49, 1968, pp. 601-606.

Gagne, R. M., "Military Training and Principles of Learning," American Psychologist, Vol. 17, No. 2, 1962, pp. 83-91.

Gagne, R. M., "The Analysis of Instructional Objectives for the Design of Instruction," Teaching Machines and Programed Learning, II: Data and Directions, edited by R. Glaser, Washington, D. C.: National Education Association, 1965, pp. 21-65.

Gagne, R. M., "The Acquisition of Knowledge," Psychological Review, Vol. 69, 1962, pp. 355-365.

Gagne, R. M., The Conditions of Learning, New York: Holt, Rinehart & Winston, 1965.

Gagne, R. M., "Curriculum Research and the Promotion of Learning," Perspectives of Curriculum Evaluation, AERA Monograph Series on Curriculum Evaluation, Chicago: Rand-McNally, No. 1, 1967, pp. 19-38.

Gagne, R. M., "Learning Hierarchies," Educational Psychologist, Vol. 6, 1968, pp. 1-9.

Gagne, R. M., and R. C. Bolles, "A Review of Factors in Learning Efficiency," in E. Galanter (ed.) Automatic Teaching: The State of the Art, New York: Wiley, 1959, pp. 13-53.

Gagne, R. M., and G. L. Gropper, The Use of Visual Examples in Review, Pittsburgh: American Institutes for Research, 1954.

Gagne, R. M., G. L. Gropper, and others, Studies in Filmed Instruction. 1. Individual Differences in Learning from Visual and Verbal Presentations. 2. The Use of Visual Examples in Review, Pittsburgh: American Institutes for Research, 1965.

Gagne, R. M., J. R. Mayor, H. L. Garstens, and N. E. Paradise, "Factors in Acquiring Knowledge of a Mathematical Task," Psychological Monographs, Vol. 76, No. 526, 1962.

Gagne, R. M., and N. E. Paradise, "Abilities and Learning Set in Knowledge Acquisition," Psychological Monographs, Vol. 75, No. 518, 1961.

Gagne, Robert M., and William D. Rohwer, "Instructional Psychology," Annual Review of Psychology, Annual Reviews, Inc., Palo Alto, California, Vol. 20, 1969, pp. 381-418.

Gallup and Robinson, Inc., Are Color TV Commercials Worth the Extra Cost?, New York Association of National Advertisers, Inc., 1965.

Garner, W. R., "An Information Analysis of Absolute Judgment of Loudness," Journal of Experimental Psychology, Vol. XLVI, 1953, pp. 373-380.

Garner, W. R., Uncertainty and Structure as Psychological Concepts, New York: Wiley, 1962.

Garry, R., and others, An Investigation of Concept Development in Elementary School Science Teaching by Television, Boston University, Boston, Mass., December, 1963.

Gerard, R., "Color and Emotional Arousal," American Psychologist (abstract) Vol. 13, 1958, p. 340.

Gibbon, S. Y., and E. L. Palmer, Pre-Reading on Sesame Street, New York: Children's Television Workshop, 1970.

Gibson, J. J., "A Theory of Pictorial Perception," AV Communication Review, Vol. 2, 1954, pp. 3-23.

Gibson, J. J., (ed.) Motion Picture Testing and Research, (Army Air Force Aviation Psychological Program Research Report No. 7) Washington: Government Printing Office, 1947.

Glaser, R., "Learning and the Technology of Instruction," AV Communication Review, Vol. IX, September-October, 1961, pp. 42-55.

Glaser, R., "Psychological Basis for Instructional Design," AV Communication Review, Vol. XIV, Winter, 1966, pp. 433-449.

Goldmark, P. C., "Communication and the Community," Scientific American, September, Vol. 227, No. 3, 1972, pp. 142-151.

Goldstein, H., Reading and Listening Comprehension at Various Controlled Rates, Teachers College Contributions to Education, 1940, New York: Bureau of Publications, Teachers College, Columbia University, No. 821.

Goldstein, K., "Some Experimental Observations Concerning the Influence of Color on the Function of the Organism," Occupational Therapy, Vol. 2, 1942, pp. 147-151.

Golfa, A., A Study of the Effects on Pupil Achievement of Certain Audio and Visual Presentation Sequences, final report, College of William and Mary, Williamsburg, Virginia, 1968.

Gordon, G. N., Classroom Television: New Frontiers in ITV, New York: Hastings House, 1970.

Graham, Clarence H., Vision and Visual Perception, John Wiley and Sons, Inc., New York, 1965.

Grant, T. S., and I. R. Merrill, Camera Placement for Recognition of Complex Behaviors, in Television and Health Science Education, NDEA Title VII Project No. 064, Washington: U. S. Office of Education, 1963, pp. 38-44.

Grant, T. S., and I. R. Merrill, Television in Health Sciences Education, San Francisco: California U. San Francisco Medical Center, September, 1963.

Green, B. F., and L. K. Anderson, "Color Coding in a Visual Search Task," Journal of Experimental Psychology, Vol. 51, 1956, pp. 19-24.

Greenhill, L. P., "Instructional Television," excerpted for "A Review of Some Trends in Research on Instructional Films and Instructional Television," in Abstracts of Research on Instructional Television and Film: An Annotated Bibliography by D. W. MacLennan, and J. C. Reid, (eds.), the material was prepared for the Institute of Communication Research, Stanford University, under a contract with the U. S. Office of Education under Title VII-B of the National Defense Education Act of 1958.

Greenhill, L. P., O. S. Rich, and C. R. Carpenter, The Educational Effectiveness, Acceptability, and Feasibility of the Eidophor Large-Screen Television Projector, University Park, Pa.: Division of Academic Research and Sciences, Pennsylvania State University, 1962.

Gregory, Richard L., Eye and Brain, the Psychology of Seeing, McGraw-Hill Book Co., New York, 1966.

*Griffith, Barton L., and Donald W. MacLennon, Improvement of Teaching by Television, Columbia, Missouri: University of Missouri Press, 1964.

Gropper, G. L., Learning from Visuals: The Application of Programming Principles to Visual Presentations, Pittsburgh: American Institutes for Research (film report), 1963.

*Gropper, G. L., Controlling Student Responses During Visual Presentations, Pittsburgh, Pa.: Metropolitan Pittsburgh Educational Television Station and American Institutes for Research, 1965.

Gropper, G. L., "A Description of the REP Style Program and Its Rationale," paper presented at NSPI Convention, Philadelphia, Pennsylvania, 1965.

*Gropper, G. L., "Learning from Visuals," AV Communication Review Vol. XIV, Spring, 1966, pp. 36-69. The research reported was supported by a grant to the Metropolitan Pittsburgh educational TV station, WQED, under the NDEA of 1958, Title VII, Grant No. 7-48-0000-120.

*Gropper, G. L., "Why is a Picture Worth a Thousand Words?" AV Communication Review, Vol. XI, July-August, 1963, pp. 75-95.

*Gropper, G. L., and A. A. Lumsdaine, An Experimental Comparison of a Conventional TV Lesson with a Programmed Lesson Requiring Active Student Response, studies in televised instruction No. 2, USOE Project No. 336, Pittsburgh: Metropolitan Pittsburgh Educational Television Stations WQED-WQEX and American Institutes for Research, March, 1961.

Gropper, G. L., and A. A. Lumsdaine, An Experimental Evaluation of the Contribution of Sequencing, Pretesting, and Active Student Responses to the Effectiveness of "Programmed" TV Instruction, studies in televised instruction No. 3, USOE Project No. 336, Pittsburgh: Metropolitan Pittsburgh Educational Television Stations WQED-WQEX and American Institutes for Research, April, 1961.

*Gross, Lynne S., Experimental Research in Educational Television, Burlingame, California: California Advisory Council on Educational Research of the California Teachers Association, Research Resume Number 37, 1968.

Grosslight, J. H., and C. J. McIntyre, Exploratory Studies in the Use of Pictures and Sound in Teaching Foregin Language Vocabulary, (Technical Report SDC 269-7-53) Instructional Film Research Reports, Port Washington, NY: U. S. Naval Special Devices Center, 1955.

Guilford, J. P., Fundamental Statistics in Psychology and Education, 4th ed., New York: McGraw-Hill, 1965.

Guilford, J. P., The Nature of Human Intelligence, New York: McGraw-Hill, 1967.

Guilford, J. P., "An Informational View of Mind," Journal of Psychological Research, Madras, Vol. VI, 1962, pp. 25-34.

Gulo, E. V., and A. Baron, "Classroom Learning of Meaningful Prose by College Students as a Function of Sensory Mode of Stimulus Presentation," Perceptual & Motor Skills, Vol. XXI, 1965, pp. 183-186.

Haber, Ralph N., "Nature of the Effect of Set on Perception," in R. Haber, ed., Contemporary Theory and Research in Visual Perception, Holt, Rinehart and Winston, Inc., New York, 1968.

Haber, Ralph N., "Perception and Memory for Pictures: Single-Trial Learning of 2560 Visual Stimuli," unpublished, 1969.

Hake, H. W., and W. R. Garner, "The Effect of Presenting Various Numbers of Discrete Steps in Scale Reading Accuracy," Journal of Experimental Psychology, Vol. XLII, 1951, pp. 358-366.

Halby, S. F., Evaluation of a Procedure for Using Daylight Film Loops in Teaching Skills, (Technical Report SDC 279-7-25) Port Washington, New York: Naval Special Devices Center, 1952.

Hall, R. L., "The Effect of Names and Titles Upon the Serial Reproduction of Pictorial and Verbal Material," British Journal of Psychology, Vol. XLI, 1950, pp. 109-121.

Halloran, J. D., The Effects of Mass Communication with Special Reference to Television: A Survey, England: Leicester University Press, 1965.

Harré, Rom, "The Formal Analysis of Concepts," in Herbert J. Klausmeier and Chester W. Harris, eds., Analysis of Concept Learning, Academic Press, New York, 1966.

Harris, Thomas A., I'm OK-You're OK, New York: Avon Books, 1969.

Harrison, J. A. (ed.), European Research in Audio-Visual Aids, London/Strasbourg: Council for Cultural Cooperation of the Council of Curope, 1966.

Hartman, E. B., "The Influence of Practice and Pitch-Distance Between Tones on the Absolute Identification of Pitch," American Journal of Psychology, Vol. LXVII, 1954, pp. 1-14.

Hartman, F. F., "Single and Multiple Channel Communication: A Review of Research and a Proposed Model," AV Communication Review, Vol. IX, November-December, 1961, pp. 235-262.

Hartman, F. R., "Filed Physics Lectures as Supplementary and Refresher College Physics Instruction," The Impact of Educational Television, edited by W. Schramm, Illinois: University of Illinois Press, 1960, pp. 117-124.

Hartman, F. R., "Recognition Learning Under Multiple Channel Presentation and Testing Conditions," AV Communication Review, Vol. 9, No. 1, 1961, pp. 24-43.

Hayes, J. R. M., "Memory Span for Several Vocabularies as a Function of Vocabulary Size," Quarterly Progress Report, Acoustics Lab., MIT, January-June, 1952.

Haygood, D. H., "Audio-Visual Concept Formation," Journal of Educational Psychology, Vol. 56, 1965, pp. 126-132.

Hayman, J. L., Jr., "A Comparison of Three Presentational Methods in Educational Television," Dissertation Abstracts, Vol. 22, 1962, pp. 3678-3679.

Hebb, D. O., A Textbook of Psychology, Philadelphia: Sanders, 1958.

Helson, Harry, Adaptation-Level Theory, Harper and Row, New York, 1964.

Henneman, R. H., "Vision and Audition as Sensory Channels for Communication," Journal of Speech, Vol. XXXVIII, 1952, pp. 161-166.

Herman, L. M., "Study of the Single Channel Hypotheses and Input Regulation with a Continuous Simultaneous Task Situation," Quarterly Journal of Experimental Psychology, Vol. XVII, 1965, pp. 37-46.

Hernandez-Peon, R., "Reticular Mechanisms of Sensory Control," Sensory Communication, W. A. Rosenblith, (ed.), New York: Wiley, 1961, pp. 497-520.

Heron, W. T., and E. W. Ziebars, "A Preliminary Experimental Comparison of Radio and Classroom Lectures," Speech Monographs, Vol. XII, 1946, pp. 54-57.

Herrel, J. G., "Instructional Television in Belgium: Proposal and Experimental Evaluation of an Appropriate Design for Effectiveness Research, and Possibilities for a New Strategy in Program Evaluation," Scientia Paedagogica Experimentalis, Vol. 9, No. 1, 1972, p. 18-51.

Hick, W. F., "On the Rate of Gain of Information," Journal of Experimental Psychology, Vol. IV, 1952, pp. 11-26.

Hilgard, Ernest R., "Learning Theory and Its Application," New Teaching Aids for the American Classroom, Stanford, California: The Institute for Communication Research, 1960, pp. 19-26.

Hill, S. D., and E. E. Hecker, "Auditory and Visual Learning of Paired Associate Task by Second Grade Children," Perceptual & Motor Skills, Vol. XXIII, 1966, p. 814.

Hirsch, R. S., The Effect of Knowledge of Test Results on Learning of Meaningful Material, (Technical Report SDC 269-7-19) Port Washington, New York: U. S. Naval Special Devices Center, 1960.

*Hoban, C. F., "From Theory to Policy Decisions," AV Communication Review, Vol. XIII, Summer, 1965, pp. 121-139.

Hoban, C. F., "Principles of Film Influence," reprinted from Instructional Film Research: 1918-1950, Technical Report No. SDC 269-7-19, Instructional Film Research Program, Pennsylvania State University, Port Washington, New York: Special Devices Center, U. S. Office of Naval Research, 1950, pp. 9.1-9.9.

Hoban, Charles F., "Research and Reality," AV Communication Review, Vol. IV, Winter, 1956, pp. 3-20.

Hoban, Charles F., "The Useable Residue of Educational Film Research," New Teaching Aids for the American Classroom, Stanford, California: The Institute for Communication Research, 1960, pp. 95-115.

Hoban, C. F., Jr., and E. B. van Ormer, Instructional Film Research: 1918-1950, Technical Report No. SDC 269-7-19, Instructional Film Research Program, Pennsylvania State College, Port Washington, New York: U. S. Special Devices Center, December, 1950.

Hochberg, Julian E., Perception, Prentice-Hall, Inc., Englewood Cliffs, New Jersey, 1966.

Hochberg, Julian, "The Psychophysics of Pictorial Perception," AV Communication Review, Vol. X, September-October, 1962, pp. 22-54.

Hoffield, D. R., and C. Kent, "Decision Time and Information Use in a Choice Situation," Psychological Reports, Vol. XII, 1963, pp. 68-70.

Hoffield, D. R., "Effect of Incentive Upon Information Use in a Choice Situation," Psychological Reports, Vol. XIII, 1963, pp. 547-550.

Holliday, W. G., "The Effects of Utilizing Simultaneous Audio and Printed Media in Science," (paper presented at the National Association for Research in Science Teaching Meeting, March, 1971), March, 1971.

Holmes, P. O., Jr., Television Research in the Teaching-Learning Process, New York: NETRC, 1960.

Hovland, C. I., "Effects of the Mass Media of Communication," Handbook of Social Psychology II, G. Lindzey, ed., Cambridge, Mass.: Addison-Wesley, 1954, pp. 1062-1103.

Hovland, C. I., A. A. Lumsdaine, and F. D. Sheffield, Experiments on Mass Communication, Princeton, New Jersey: Princeton University Press, 1949.

*Hsia, H. J., "On Channel Effectiveness," AV Communication Review, Vol. 16, No. 3, 1968, pp. 245-267.

*Hsia, H. J., "The Information Processing Capacity of Modality and Channel Performance," AV Communication Review, Vol. 19, 1971, pp. 51-75.

Hsia, H. J., "Effects of Redundancy and Noise in Two-Channel Information Processing," unpublished doctoral thesis, University of Wisconsin, 1967.

Hubel, D. H., and T. N. Wiesel, "Receptive Fields, Binocular Interaction, and Functional Architecture in the Cat's Visual Cortex," in Ralph N. Haber, ed., Contemporary Theory and Research in Visual Perception, New York: Holt, Rinehart and Winston, 1968.

Hudson, W., "Color vs. Monochrome in a Demonstration Film Used to Administer Performance Tests for the Classification of African Workers," Journal of National Institute of Personnel Research, Johannesburg, Vol. 7, 1958, p. 128.

Hull, C. L., Principles of Behavior, New York: Appleton-Century-Crofts, 1943.

Hunt, E. B., Concept Learning: An Information Processing Problem, New York: Wiley, 1962.

Hyman, R., "Stimulus Information as Determinant of Reaction Time," Journal of Experimental Psychology, Vol. XLV, 1953, pp. 188-196.

Ibison, R. A., "Differential Effects in the Recall of Textual Materials Associated with the Inclusion of Colored and Uncolored Illustrations," unpublished doctoral dissertation, Indiana University, Bloomington, 1952.

Inase, Hiraski, "Communication Networks," Scientific American, Vol. 227, No. 3, September, 1972, pp. 116-129.

Instructional Film Research Program, Evaluation of the Film: Military Police Support in Emergencies (Riot Control), TF 19-1701, (Technical Report SDC 269-7-52). Port Washington, New York: U. S. Naval Special Devices Center, 1954.

Isaacs, Dan Lee, The Effects on Learning of the Color Coding of Pictorial Stimuli, Bloomington: Indiana University AV Center, September, 1969.

Ishikawa, K., A Study of Teaching Methods with Educational Films, Maebashi City, Japan: Prefectural Educational Research Institute, 1959.

Jacobson, H., "The Information Capacity of the Human Ear," Science, Vol. CXII, 1950, pp. 143-144.

Jacobson, H., "The Information Capacity of the Human Eye," Science, Vol. CXIII, 1951, pp. 292-293.

Japan Broadcasting Co., Toyko, Survey and Study of Educational Broadcasts: 1960-1968, 1969.

Jaspen, N., Effects on Training of Experimental Film Variables, Audience Participation, (Technical Report SDC 269-7-11) Port Washington, New York: U. S. Naval Special Devices Center, March, 1950.

Jaspen, N., Effects on Training of Experimental Film Variables. Study 1: Verbalization, Rate of Development, Nomenclature, Errors, How-It-Works, Repetition, Technical Report SDC 269-7-17, ASTIA Doc. No. 45501, University Park, Pennsylvania State College, Instructional Film Research Program, October, 1950.

Jenkins, Joseph R., Daniel C. Neale, Stanley L. Deno, "Differential Memory for Picture and Word Stimuli," Journal of Educational Psychology, Vol. 58, 1967, pp. 303-307.

Johnson, Donald M., The Psychology of Thought and Judgment, New York: Harper & Bros., 1955.

Jones, H. E., "The Influence of Motion Picture Upon the Social Attitudes of Children," Journal of American Association of University Women, Vol. XXVII, 1934, pp. 419-429.

Jordon, J. R., The National Center for School and College Television--A Demonstration of a National Program Agency for Instructional Television, Final Report, Bloomington: Indiana University Foundation, 1968.

Kagan, J., "The Determinants of Attention in the Infant," American Scientist, Vol. 58, 1970, pp. 298-306.

Kagan, J., "Cognitive Development and Programs for Day Care," in Edith H. Gortberg (ed.), Day Care: Resources for Decisions, Washington, D. C.: Office of Economic Opportunity, 1971, pp. 135-152.

Kagan, J., Change and Continuity in Infancy, New York: Wiley, 1971.

Kagan, J., and N. Kogan, "Individuality and Cognitive Performance," in P. H. Mussen (ed.), Manual of Child Psychology, New York: Wiley, 1970, pp. 1273-1365.

*Kanner, Joseph H., The Instructional Effectiveness of Color in Television--A Review of the Evidence, Using Educational Media--Guides to the Literature, Series 1, Stanford, California: Stanford University, Institute for Communications Research, 1968.

Kanner, J. H., and A. J. Rosenstein, "Television in Army Training: Color vs. Black and White," AV Communication Review, Vol. 8, 1960, pp. 243-252.

Kanner, J. H., and A. J. Rosenstein, "Television and Army Training: Color vs. Black and White," AV Communication Review, Vol. 9, 1961, pp. 44-49.

Kanner, J. H., R. P. Runyon, and O. Desiderato, Television in Army Training: Evaluation of Television in Army Basic Training, Technical Report HumRRO14, Washington, D. C.: George Washington University, Human Resources Research Office, 1954.

Kantor, B. R., "Effectiveness of Inserted Questions in Instructional Films," AV Communication Review, Vol. 8, 1960, pp. 104-108.

Kaplan, R., "Teaching Problem-Solving with Television to College Freshmen in Health Education," Dissertation Abstracts, Vol. 23, 1963, pp. 3224-3225.

Katz, P. A., and M. Deutsch, "Modality of Stimulus Presentation in Material Learning for Retarded and Normal Readers," Perceptual and Motor Skills, Vol. 19, 1964, pp. 627-633.

Katz, P. A., and M. Deutsch, Visual and Auditory Efficiency and Its Relationship to Reading in Children, Final Report, Project 1099, Washington, D. C.: Cooperative Research Program, Office of Education, 1963.

*Katzman, N., and J. Nyenhuis, "Color vs. Black and White Effects on Learning, Opinion, and Attention," AV Communication Review, Vol. 20, Spring, 1972, pp. 16-28.

Kazem, A. K. M., "An Experimental Study of the Contribution of Certain Instructional Films to the Understanding of the Elements of Scientific Method by Tenth-Grade High School Biology Students," Dissertation Abstracts, Vol. 21, 1961, p. 3019.

Kelley, T. L., et al., Stanford Achievement Test, New York: Harcourt, Brace and World, 1964.

Kelman, Alfred R., Television Junior College in Oregon, 1959-62, Preliminary Report 2, Monmouth, Oregon: Oregon State System of Higher Education, Teaching Research Division, October, 1962.

Kendler, T. S., J. O. Cook, and H. H. Kendler, "An Investigation of the Interacting Effects of Repetition and Audience Participation on Learning From Training Films," American Psychologist, Vol. 8, 1953, pp. 378-379.

Ketcham, C. H., and R. W. Heath, "The Effectiveness of an Educational Film Without Direct Visual Presentation of Content," AV Communication Review, Vol. 11, 1963, pp. 114-123.

Kimble, G. A., and J. J. Wulff, "The Effects of Response 'Guidance' on the Value of Audience Participation in Training Film Instruction," Human Factors Operations Research Laboratories, USAF (Report No. 35), AV Communication Review, Vol. 1, 1953, pp. 292-293.

Kirk, R. E., Experimental Procedures for the Behavioral Sciences, Belmont, California: Brooks Cole, 1969.

Kishler, J. P., "The Differential Prediction of Learning from a Motion Picture by Means of Indices of Identification Potential Derived from Attitudes Toward the Main Character," Abstracts of Doctoral Dissertations, The Pennsylvania State College, 13, State College, Pa.: The Pennsylvania State College, 1951, pp. 407-413.

Klapper, J. T., "The Comparative Effects of the Various Media," The Process and Effects of Mass Communication, W. Schramm (ed.), Urbana: University of Illinois Press, 1954, pp. 91-105.

Klaus, D. J., "An Analysis of Programing Techniques," Teaching Machines and Programed Learning, II: Data and Directions, R. Glaser (ed.), Washington, D. C.: National Education Association, 1965, pp. 118-161.

Klaus, D. J., "Personal Communication," 1965.

Klemmer, E. T., "Time Sharing Between Auditory and Visual Channels," Air Force Engineering Personnel, and Training Research Publ. 455, G. Finch and F. Cameron (eds.), Washington: National Academy of Sciences-National Research Council, 1956, pp. 199-203.

Klemmer, E. T., "Time Sharing Between Frequency Coded Auditory and Visual Channels," Journal of Experimental Psychology, Vol. LV, 1958, pp. 229-235.

Knowlton, James Q., A Socio- and Psycho-Linguistic Theory of Pictorial Communication, Lafayette: Indiana University, Division of Educational Media and Audio-Visual Center, 1964, U. S. Office of Education, Contract No. 3-16-019.

*Knowlton, J. Q., "On the Definition of 'Picture'," AV Communication Review, Vol. XIV, Summer, 1966, pp. 157-183.

Koebner, L., "The Quintessence of the Dream in Modern Biology," International Journal of Neuropsychiatry, Vol. 2, No. 6, 1966, pp. 562-571.

Kopstein, F. F., and S. M. Roshal, "Learning Foreign Vocabulary From Pictures Versus Words," paper presented at meetings of American Psychological Association, September, 1954, (abstracted in American Psychologist, Vol. IX, 1954), pp. 407-408.

Kopstein, F. F., and S. M. Roshal, "Verbal Learning Efficiency as Influenced by the Manipulation of Representational Response Processes: Pictorial-Verbal and Temporal Contiguity Factors," in A. A. Lumsdaine (ed.), Student Response in Programed Instruction, Publication 943, Washington, D. C.: National Academy of Sciences, National Research Council, 1961, pp. 335-350.

Koran, M. L., and others, The Effects of Individual Differences on Observational Learning in the Acquisition of a Teaching Skill, (presented at the annual meeting of the American Educational Research Association, Los Angeles, California), February, 1969.

Kouwer, B., "Colors and Their Character," Martinus Nijoff, 1949.

Kress, G. C., Jr., and G. L. Gropper, Individual Differences in Learning From Self-Paced Programmed Instruction, Report No. 1, Studies in Televised Instruction: Individualizing Group Instruction, Pittsburgh: American Institutes for Research, 1964.

Kretzmer, E. R., "Communication Terminals," Scientific American, Vol. 227 No. 3, September, 1972, pp. 130-141.

Kumata, H., An Inventory of Instructional Television Research, Ann Arbor, Michigan: Educational Television and Radio Center, 1956.

Kumata, H., "A Decade of Teaching by Television," The Impact of Educational Television, W. Schramm (ed.), Illinois: University of Illinois Press, 1960, pp. 176-194.

Kumata, H., "Attitude Change as a Function of Prestige of Instructor and Mode of Presentation," The Impact of Educational Television, W. Schramm (ed.), Urbana: University of Illinois Press, 1960, pp. 157-174.

Kumata, H., "Two Studies in Classroom Teaching," The Impact of Educational Television, W. Schramm (ed.), Urbana: University of Illinois Press, 1960, pp. 151-157.

Kuparadz, R., "Plastic Properties of the Axons of the Brain," Sovremennye Problemy Deyatel'Nosti I Stroeniya Tsentral' Noi2 Sistemy, Vol. 14, 1965, pp. 213-226.

LaJeunesse, L., and R. Rossi, "Influence de Certains Modifications de la Structure des Films sur l'Intégration des Contenus Cinématographiques par des Enfants d'Age Scolaire," Revue Internationale de Filmologie, Vol. 10, 1966, pp. 90-100.

Laner, S., "Some Factors Influencing the Effectiveness of an Educational Film," British Journal of Psychology, Vol. 46, 1955, pp. 280-292.

Langer, S. K., Philosophy in a New Key, Cambridge, Mass.: Harvard University Press, 1942.

Leboutet, L., "Recherches sur les Émissions de Télévision Scolaire (1ére Series). (a) L'Influence de la Présentation des Objects," Rapport de Recherche du Centre Audio-Visuel, Normale Supéricure de Saint-Cloud, 1956.

Leonard, J. A., "An Experiment with Occasional False Information," Quarterly Journal of Experimental Psychology, Vol. VI, 1954, pp. 79-85.

Leont'ev, A. N., and E. P. Krinchik, "On Some Properties of the Process of Information Handling by Men," Voprosy Psikhologii, Vol. VIII, 1952, pp. 14-25.

Levonian, E., "Auditory and Visual Retention in Relation to Arousal," AV Communication Review, Vol. 16, No. 1, 1968, pp. 57-62.

Lewis, C. I., Mind and the World Order, New York: Dover Publications, 1956.

Licklider, J. C. R., "On the Process of Speech Perception," Journal of the Acoustical Society of America, Vol. XXIV, 1952, pp. 590-594.

Long, L., and L. Welch, "Influence of Abstractness on Reasoning Ability," Journal of Psychology, Vol. XIII, 1942, pp. 41-59.

Lordahl, D. S., "Concept Identification Using Simultaneous Audio and Visual Signals," Journal of Experimental Psychology, Vol. 62, 1964, pp. 283-290.

Luborsky, Lester, Barton Blinder, and Norman Mackworth, "Eye Fixation and Recall of Pictures as a Function of GSR Responsivity," Perceptual and Motor Skills, Vol. 16, 1963, pp. 469-483.

Luce, Duncan R., "The Theory of Selective Information and Some of Its Behavioral Applications," Developments in Mathematical Psychology, D. R. Luce (ed.), Glencoe, Illinois: Free Press, 1960, pp. 5-124.

Lumsdaine, A. A., Student Response in Programmed Instruction, Washington: National Academy of Sciences, National Research Council, 1961.

Lumsdaine, A. A., "The Effectiveness of Pictures Versus Printed Words in Learning Simple Verbal Associations," unpublished Ph.D. dissertation, Stanford University, 1949.

Lumsdaine, A. A., R. L. Sulzer, and F. F. Kopstein, "The Influence of Simple Animation Techniques on the Value of a Training Film," Human Resources Research Laboratories (Report No. 24), April, 1951, AV Communication Review, Vol. 1, 1953, pp. 140-141.

Lumsdaine, A. A., "Cue and Response Functions of Pictures and Words," Learning From Films, M. A. May and A. A. Lumsdaine (eds.), New Haven: Yale University Press, 1958, pp. 123-149.

Lumsdaine, A. A., "Instruments and Media of Instruction," in N. L. Gage (ed.), Handbook of Research on Teaching, Chicago: Rand-McNally, 1963, pp. 583-682.

Lumsdaine, A. A., and A. Gladstone, "Overt Practice and Audio-Visual Embellishments," Learning From Films, M. A. May and A. A. Lumsdaine (eds.), New Haven: Yale University Press, 1958, pp. 58-71.

Lumsdaine, A. A., M. A. May, and R. S. Hadsell, "Questions Spliced into a Film for Motivation and Pupil Participation, in M. A. May and A. A. Lumsdaine, Learning From Films, New Haven: Yale University Press, 1958, pp. 72-83.

Lumsdaine, A. A., "Experimental Research on Instructional Devices and Materials, in R. Glaser (ed.), Training Research and Education, New York: Wiley, 1962.

Maccoby, E. E., "Selective Auditory Attention in Children," in L. P. Lipsett and C. C. Spiker (eds.), Advances in Child Development and Behavior: Vol. III, New York: Academic Press, 1967, pp. 99-124.

Maccoby, E. E., "Early Stimulation and Cognitive Development," in J. P. Hill (ed.), Minnesota Symposia on Child Psychology, Minneapolis: University of Minnesota Press, 1969, pp. 68-96.

Maccoby, E. E., and K. W. Konrad, "The Effect of Preparatory Set on Selective Listening: Developmental Trends," Monographs of the Society for Research in Child Development, No. 112, 1967.

Maccoby, N., and F. D. Sheffield, "Combining Practice and Demonstration in Teaching Complex Sequences: Summary and Interpretation," in Lumsdaine, q.v. Ch. 5, 1961.

MacKenzie, N., and others, Teaching and Learning. An Introduction to New Methods and Resources in Higher Education, Paris, France UNESCO, 1970.

Mackworth, Norman H., and Anthony J. Morandi, "The Gaze Selects Informative Details Within Pictures," Perception and Psychophysics, Vol. 2, 1967, pp. 547-552.

MacLean, W. P., "A Comparison of Colored and Uncolored Pictures," Educational Screen, Vol. 9, 1930, pp. 196-199.

*MacLennan, D. W., and J. C. Reid, A Survey of the Literature of Learning and Attitude Research in Instructional Television, Columbia: University of Missouri, Department of Speech, 1963.

*MacLennan, Donald W., and J. Christopher Reid, Abstracts of Research on Instructional Television and Film: An Annotated Bibliography, Stanford, California: Institute for Communication Research, 1964.

Malandin, Claude, Grouped and Successive Images, Saint Cloud, France: Centre d'Etudes et de Recherches pur la Diffusion du Francais (CREDIF), Ecole Normale Superieur de Saint Cloud, n.d.

Malandin, Claude, Research on the Understanding of Film Strips, Saint Cloud, France: Ministere de l'Education Nationale, Ecole Normale Superieur de Saint Cloud, n.d.

Malandin, Claude, Screen Perception and Audio Visual Techniques, Seminar in the Psychology of Audio Visual Means in Elementary Teaching, Caen, France: UNESCO, Commission de la Republique Française pour l'Education la Science, et la Culture, May 3-12, 1962.

May, M. A., "Do 'Motivation' and 'Participation' Questions Increase Learning?" Educational Screen, Vol. 26, 1947, pp. 256-283.

May, M. A., "Enhancements and Simplifications of Motivational and Stimulus Variables in Audiovisual Instructional Materials" (a working paper), Washington: U. S. Office of Education, 1965.

May, M. A., "Word-Picture Relationships in Audio-Visual Presentations," working paper, July, 1965, Contract No. OE-5-16-006, Washington, D. C.: U. S. Department of Health, Education and Welfare, Office of Education.

May, M. A., and N. L. Jenkinson, "Developing Interest in Reading with Film," AV Communication Review, Vol. 1, 1953, pp. 159-166.

May, M. A., and A. A. Lumsdaine, Learning From Films, New Haven, Conn.: Yale University Press, 1958.

McAllister, D. E., "The Effects of Various Kinds of Relevant Verbal Pretraining on Subsequent Motor Performance," Journal of Experimental Psychology, Vol. XLVI, 1953, pp. 329-336.

McCormick, M. C., R. M. W. Travers, A. P. Van Mondfrans, and F. E. Williams, Research and Theory Related to Audiovisual Information Transmission, Interim Report, Salt Lake City: University of Utah, Bureau of Educational Research, 1964.

McCormick, E. J., Human Engineering, New York: McGraw-Hill, 1958.

McDougall, R., "Recognition and Recall," Journal of Philosophy and Scientific Method, Vol. I, 1904, pp. 229-233.

McGeoch, J. A., The Psychology of Human Learning, New York: Longmans, Green, 1942.

McGuire, W. J., "Audience Participation and Audio-Visual Instruction: Overt-Covert Responding and Rate of Presentation," A. A. Lumsdaine (ed.), Student Response in Programmed Instruction, Washington: National Academy of Sciences, National Research Council, 1961.

McGuire, W. J., "Some Factors Influencing the Effectiveness of Demonstrational Films: Repetition of Instructions, Slow Motion, Distribution of Showings, and Explanatory Narration," in A. A. Lumsdaine, Student Response in Programmed Instruction, Washington: National Academy of Sciences, National Research Council, 1961.

McIntyre, Charles J., in B. L. Griffith and Donald W. Mac Lennon (ed.), Improvement of Teaching by Television, Columbia, Mo.: University of Missouri Press, 1964.

McNiven, , Effects on Learning of the Perceived Usefulness of the Material to be Learned, (Technical Report SDC 269-7-54) Port Washington, New York: U. S. Naval Special Devices Center, 1955.

Mercer, J., The Relationship of Optical Effects and Film Literacy to Learning From Instructional Films, (Technical Report SDC 269-7-34) Port Washington, New York: U. S. Naval Special Devices Center, 1952.

Mead, C. D., "Silent Versus Oral Reading with One Hundred Sixth-Grade Children," Journal of Educational Psychology, Vol. VI, 1915, pp. 345-348.

Mednick, S. A., and J. L. Freedman, "Stimulus Generalization," Psychological Bulletin, Vol. LVII, 1960, pp. 169-200.

Meichenbaum, D. H., L. Turk, and J. M. Rogers, "Implications of Research on Disadvantaged Children and Cognitive-Training Programs for Educational Television: Ways of Improving 'Sesame Street'," Journal of Special Education, Vol. 6, No. 1, Spring, 1972, pp. 27-50.

Meierhenry, W. C., (ed.) "Learning Theory and AV Utilization," AV Communication Review, Vol. IX, September-October, 1961, pp. 1-88.

Meisler, R. A., Technologies for Learning, HEW, OE Bureau of Research, BR-8-0571, 1970.

Menne, J. M., and J. W. Menne, "The Relative Efficiency of Bimodal Presentation as an Aid to Learning," AV Communication Review, Vol. 20, No. 2, Summer, 1972, pp. 170-184.

Merrill, Irving G., in B. L. Griffith and Donald W. MacLennon (ed.) Improvement of Teaching by Television, Columbia, Mo.: University of Missouri Press, 1964.

Mialaret, G., and M. G. Melies, "Expérience sur la Compréhension du Language Cinématrographique par l'Enfant," Revue International de Filmologie, Vol. 5, 1954, pp. 221-228.

Michael, D. N., and E. Maccoby, "Factors Influencing Verbal Learning from Films under Varying Conditions of Audiences Participation," Journal of Experimental Psychology, Vol. XLVI, 1953, pp. 411-418.

*Miller, George A., "The Magical Number Seven, Plus or Minus Two: Some Limits on Our Capacity for Processing Information," in Ralph H. Haber, (ed.), Contemporary Theory and Research in Visual Perception, New York: Holt, Rinehart and Winston, Inc., 1968.

Miller, G. A., "Information Theory and the Study of Speech," Current Trends in Information Theory, G. McMillan, et al., (ed.) Pittsburgh: University of Pittsburgh Press, 1953, pp. 119-139.

Miller, J. G., "The Individual as an Information Processing System," Information Storage and Neural Control, W. S. Fields and W. Abbott, (eds.) Springfield, Illinois: Charles C. Thomas, 1963, pp. 301-328.

Miller, N. E., and others, Graphic Communication and the Crisis in Education, Washington, D. C.: National Education Association, 1957, (see also AV Communication Review, Vol. V, December, 1957, pp. 3-113).

Miller, R. B., A Suggested Guide to Functional Characteristics of Training and Training Equipment, Technical Memorandum ML-TM-56-14, Lackland Air Force Base, Texas: Air Force Personnel and Training Research Center, 1956.

*Miller, W. A. "What Children See in Pictures," Elementary School Journal, Vol. 39, 1938, pp. 280-288.

Moldstad, J., "Readability Formulas and Film Grade-Placement," AV Communication Review, Vol. 3, 1955, pp. 99-108.

Moore, D. M., "An Experimental Study of the Value of the Size and Type of Still Projected Pictures on Immediate Recall of Content," unpublished doctoral dissertation, Southern Illinois University.

Moore, David M., and E. B. Sasse, "Effect of Size and Type of Still Projected Pictures on Immediate Recall of Content," AV Communication Review, Vol. 19, No. 4, Winter, 1971, pp. 437-450.

Moore, K. C., "The Mental Development of a Child," Psychological Review Monograph Supplement, Vol. 1, No. 3, 1896.

Moray, N., "Where Is Capacity Limited? A Survey and a Model," in Andries F. Sanders, (ed) Attention and Performance, North-Holland Publishing Co., Amsterdam, 1967.

Morris, Charles, Signs, Language and Behavior, New York: Prentice-Hall, 1946.

Morrisett, L., Jr., and C. I. Hovland, "A Comparison of Three Varieties of Training in Human Problem Solving," Journal of Experimental Psychology, Vol. LVIII, 1958, pp. 52-55.

Mowbray, G. H., "Simultaneous Visions and Audition: The Comprehension of Prose Passages with Varying Levels of Difficulty," Journal of Experimental Psychology, Vol. 46, 1953, pp. 365-372.

Mowbray, G. H., "The Perception of Short Phrases Presented Simultaneously for Visual and Auditory Reception," Quarterly Journal of Experimental Psychology, Vol. 6, 1954, pp. 86-92.

Mowbray, G. H., "Simultaneous Vision and Audition: The Detection of Elements Missing from Overlearned Sequences," Journal of Experimental Psychology, Vol. XLIV, 1952, pp. 292-300.

Mudd, S. A., and E. J. McCormick, "The Use of Auditory Cues in a Visual Search Task," Journal of Applied Psychology, Vol. XLIV, 1960, pp. 184-188.

Muntone, J. C., "The Effects of Variables in Instructional Television on Acquisition of Information and Attitudes," Dissertation Abstracts, Vol. 23, 1963, pp. 4264-4265.

Murdock, B. B., "A Test of the 'Limited Capacity' Hypothesis," Journal of Experimental Psychology, Vol. LXIX, 1965, pp. 237-240.

Murdock, B. B., Jr., "Visual and Auditory Stores in Short-Term Memory," Quarterly Journal of Experimental Psychology, 1966, pp. 206-211.

Murnin, J. A., K. R. Moll, and N. Jaspen, Comparison of Training Media: Trainee Manipulation and Observation of Functioning Electrical Systems vs Trainee Drawing of Schematic Electrical Systems, Technical Report SDC 269-7-101, Port Washington, NY: U. S. Naval Special Devices Center, 1954.

Myers, L., Jr., An Experimental Study of the Influence of the Experienced Teacher on Television, Syracuse, NY: Syracuse University, 1961.

Naeslund, J., Experiments With Closed Circuit Television, Stockholm, Sweden: Stockholm School of Education, Institute of Educational Psychology, October, 1967.

Napalkow, A. V., and M. I. Bobneva, "Analysis of Information Processes of Man's Brain," Voprosy Psikhologii, Vol. VIII, 1962, pp. 40-54.

Nebylitsyn, V. D., "Individual Differences in the Strength and Sensitivity of Both Visual and Auditory Analyzers," Voprosy Psihologii, Vol. IV, 1957, pp. 53-69. (Translated by Ruth Kisc, Recent Soviet Psychology, edited by N. O'Connor, New York: Liveright, 1961, pp. 52-74.)

*Neisser, Ulric, Cognitive Psychology, Appleton-Century-Crofts, New York, 1967.

Neligan, G. A., "The Effects of Intrauterine Malnutrition Upon Later Development in Humans," Psychiatria, Neurologia, Neurochirurgia, Vo . 74, No. 6, November, 1971, pp. 454-461.

Nelson, George, "Art X: The Georgia Experiment," Industrial Design, October, 1954, p. 44.

Nelson, H. E., "The Relative Contributions to Learning of Video and Audio Elements in Films," Progress Report No. 13, Instructional Film Research Program, University Park: Pennsylvania State University, 1949.

Nelson, H. E., and K. R. Moll, Comparison of the Audio and Video Elements of Instructional Films, Technical Report SDC 269-7-18, Port Washington, NY: U. S. Naval Special Devices Center, 1950.

Nelson, H. E., and A. W. VanderMeer, The Relative Effectiveness of Differing Commentaries in an Animated Film on Elementary Meteorology, Technology Report SDC 269-7-43, Port Washington, NY: U. S. Naval Special Devices Center, 1955.

Neu, D. M., The Effect of Attention-Gaining Devices on Film-Mediated Learning, Technical Report SDC 269-7-9, Instructional Film Research Program, University Park: Pennsylvania State University, 1950.

Norberg, Kenneth, "Perception Research and Audio-Visual Education," AV Communication Review, Vol. I, Winter, 1953, pp. 18-29.

Norberg, Kenneth, editor, Perception Theory and AV Education. AV Communication Review, Supplement 5, Vol. X, October, 1962.

*Norberg, Kenneth, "Visual Perception Theory," AV Communication Review, Vol. XIV, Fall, 1966, pp. 301-317.

Northrop, D. S., Effects on Learning of the Prominence of Organizational Outlines in the Instructional Film, Technical Report SDC 269-7-33, Port Washington, NY: U. S. Naval Special Devices Center, 1952.

O'Brien, F. J., "A Qualitative Investigation of the Effect of Mode of Presentation Upon the Process of Learning," American Journal of Psychology, Vol. XXXII, 1921, pp. 249-283.

Olson, D. R., "Cognitive Development, The Child's Acquisition of Diagonality," New York: Academic Press, 1970.

Ontario Curriculum Institute, Toronto, Technology in Learning. An Interim Report of the Study Committee on Instructional Aids and Techniques, May, 1965.

Osgood, C. E., Method and Theory in Experimental Psychology, New York: Oxford University Press, 1953.

Otto, W., and E. Askov, "The Role of Color in Learning and Instruction," Journal of Special Education, Vol. 2, 1968, pp. 155-165.

Paivio, Allen, "Paired-Associate Learning and Free Recall of Nouns as a Function of Concreteness, Specificity, Imagery, and Meaningfulness," Psychological Reports, Vol. 20, 1967, pp. 239-245.

Paivio, Allen, and A. D. Yarmey, "Pictures Versus Words as Stimuli and Responses in Paired-Associate Learning," Psychonomic Science, Vol. 5, 1966, pp. 235-236.

Palka, Y., R. A. Liebelt, and V. Critchlow, "Obesity and Increased Growth Following Partial or Complete Isolation of Ventromedial Hypothalamus," Physiology and Behavior, Vol. 7, No. 2, August, 1971, pp. 187-194.

Palmer, E. L., and others, A Comparative Study of Current Programs for Preschool Children, Final Report, Monmouth: Oregon State System of Higher Education, Teaching Research Division, HEW/OE Bureau of Research BR-5-1120, OEG-4-6-051120-1179, June, 1968.

Pan, S., "The Influence of Context Upon Learning and Recall," Journal of Experimental Psychology, Vol. IX, 1926, pp. 468-491.

Pannitt, M., ed., TV and Your Child: In Search of An Answer, Radnor, Pa.: TV Guide, 1969.

Parker, J. F., Jr., and J. E. Downs, Selection of Training Media, Technical Report No. 61-473, September, 1961, Wright-Patterson Air Force Base, Ohio, Behavioral Sciences Laboratory, Aerospace Medical Laboratory, Aeronautical Systems Division, Air Force Systems Command, United States Air Force.

Peirce, Charles Sanders, Collected Papers of Charles Sanders Peirce, Volume II, Elements of Logic, edited by Charles Hartshorne and Paul Weiss, Cambridge: Harvard University Press, 1932.

Penfield, W., "Memory Mechanisms," A.M.A. Archives of Neurology and Psychiatry, Vol. 67, 1952, pp. 179-198, with discussion by L. S. Kubie, et.al.

Peterson, L. R., and M. J. Peterson, "The Role of Context Stimuli in Verbal Learning," Journal of Experimental Psychology, Vol. 53, 1957, pp. 102-105.

Piaget, J., and B. Inhelder, The Child's Conception of Space, London: Routledge and Kegan Paul, 1956.

Pierce, J. R., "Communication," Scientific American, Vol. 227, No. 3, September, 1972, pp. 30-41.

Pierce, J. R., Symbols, Signals and Noise: The Nature and Process of Communication, New York: Harper & Row, 1961.

Pimsleur, P., D. M. Sundland, R. J. Bonkowski, and Mosberb, "Further Study of the Transfer of Verbal Materials Across Sense Modalities," Journal of Educational Psychology, Vol. LV, 1964, pp. 96-102.

Platt, H., and others, Automation in Vocational Training of the Mentally Retarded, Final Report, Devereux Foundation, Devon, Pa., Institute of Research and Training, sponsored by Vocational Rehabilitation Administration, DHEW, Washington, D. C., Grant No. VRA-R-993-P-630, 1966.

Pockrass, R. M., "Effects on Learning of Continuous and Interrupted Exhibition of Educational Television Programs," Dissertation Abstracts, Vol. 21, 1961, p. 870.

Pollack, I., "The Information of Elementary Auditory Display," Journal of Acoustic Society of America, Vol. XXIV, 1952, pp. 745-750.

Pollack, I., "The Information of Elementary Auditory Display, II," Journal of Acoustic Society of America, Vol. XXIV, 1952, pp. 765-769.

Pollack, I., and L. Fick, "Information of Multidimensional Auditory Displays," Journal of Acoustic Society of America, Vol. XXVI, 1954, pp. 155-158.

Postlethwait, S. N., J. Novak, and H. T. Murray, Jr., The Audiotutorial Approach to Learning, second edition, Minneapolis: Burgess Publishing, 1969.

Posner, M. I., and E. Rossman, "Effect of Size and Location of Infornation Transforms Upon Short-Term Retention," Journal of Experimental Psychology, Vol. LXX, 1965, pp. 496-505.

Postman, L., "Human Learning and Audiovisual Education," AV Communication Review, Vol. IX, September-October, 1961, pp. 68-78.

Postman, Leo, and Laura, Phillips, "Studies in Incidental Learning: I. The Effects of Crowding and Isolation," Journal of Experimental Psychology, Vol. XLVIII, 1954, pp. 48-56.

Potter, M. C., and E. I. Levy, "Recognition Memory for a Rapid Sequence of Pictures," Journal of Experimental Psychology, Vol. 81, No. 1, 1969, pp. 10-15.

Prouse, Derek, "Dynamic Frame," Sight amd Sound, Vol. XXV, 1956, pp. 159-160.

Pryluck, C., and R. E. Snow, "Toward a Psycholinguistics of Cinema," AV Communication Review, Vol. 15, No. 1, 1967, pp. 54-57.

Quastler, H., ed., Information Theory in Psychology: Problems and Methods, Glencoe, Ill: Free Press, 1955.

Rappaport, M., "The Role of Redundancy in the Discrimination of Visual Forms," Journal of Experimental Psychology, Vol. 53, 1957, pp. 3-10.

Reed, H. B., "The Learning and Retention of Concepts: IV, Influence of Complexity of Stimuli," Journal of Experimental Psychology, Vol. XXXVI, 1946, pp. 252-261.

Reed, H. B., "The Learning and Retention of Concepts: V, The Influence of Form of Presentation," Journal of Experimental Psychology, Vol. XL, 1950, pp. 504-511.

Reede, A. H., and R. K. Reede, "Televising Instruction in Elementary Economics," Industrial Research Bulletin No. 5, University Park, Pa.: College of Business Administration, Pennsylvania State University, 1963.

Reeves, B. F., "The First Year of Sesame Street: The Formative Research," New York: Children's Television Workshop, 1970.

Reeves, B. F., "The Responses of Children in Six Small Viewing Groups to Sesame Street Shows Nos. 261-274," New York: Children's Television Workshop, 1971.

*Reich, Carol, and Alan Meisner, A Comparison of Colour and Black and White T.V., Toronto, Ontario, Canada: The Board of Education for the City of Toronto, Research Department, 1972 (#110).

*Reid, C., and D. W. MacLennan, Instructional Television and Film: Summary of Studies, Washington: U. S. Office of Education, 1967.

Richards, O. W., and P. Macklin, "Colored Overhead Transparencies: Contrast Gain or Seeing Loss?" AV Communication Review, Vol. 19, No. 4, Winter, 1971, pp. 432-436.

Rimland, B., Effectiveness of Several Methods of Repetition of Films, Technical Report SDC 269-7-45, Port Washington, NJ: U. S. Naval Special Devices Center, 1955.

Ringel, S., and F. L. Vicino, Information Assimilation from Symbolic Displays: Amount of Information Presented and Removed, USA PRO Technical Research Note, No. 139, 1964.

Robinson, J. H., and others, Bimodal Educational Inputs to Educable Mentally Retarded Children, Final Report, Silver Spring, Md.: American Institutes for Research, National Institutes of Health, Bethesda, Md. Report No. AIR-E-49-9-66-FR, Grant No. MH-10819-01, September, 1966.

Rock, R. T., Jr., and others, Training by Television--A Study in Learning and Retention, Port Washington, NY: Special Devices Center, Office of Naval Research, SDC-476-02-3.

Rodriguez Bou, I., "Estudio Sobre Preferencias Cromaticas y Tipos de Ilustraciones," Rio Piedras, Puerto Rico: Superior Educational Council, 1950, cited by Spaulding, AV Communication Review, Vol. 3, No. 1, 1955, p. 43.

Rohwer, William D., Jr., Steve Lynch, Nancy Suzuki, and Joel R. Levin, "Verbal and Pictorial Facilitation of Paired-Associate Learning," Journal of Experimental Child Psychology, Vol. 5, 1967, pp. 294-302.

Rose, Nicholas, and C. Van Horn, "Theory and Application of Preproduction Testing," AV Communication Review, Vol. IV, Winter, 1956, pp. 21-30.

Roshal, S. M., Effects of Learner Representation in Film-Mediated Perceptual-Motor Learning, Technical Report No. 279-705, Pennsylvania State University Instructional Research Program, Port Washington, NY: U.S. Naval Special Devices Center, 1949.

Roshal, S. M., "The Instructional Film," in G. Finch (ed.) Education and Training Media: A Symposium, Washington, D.C.: National Academy of Sciences-National Research Council, Publication, No. 789, 1960, pp. 114-121.

Roshal, S. M., "Film-Mediated Learning with Varying Representation of the Task: Viewing Angle, Portrayal of Demonstration, Motion and Student Participation," in A. A. Lumsdaine (ed.), Student Response in Programmed Instruction: A Symposium, Publication No. 943, Washington, D.C.: National Academy of Sciences, National Research Council, 1961, pp. 155-175.

Roshka, A. Usloviia, "Sposobstvuiuschchis Abstragirovaniiu i Obobschcheniiu," ("Conditions Facilitating Abstraction and Generalization,") Voprosky Psikhologii, Vol. IV, 1958, pp. 89-96, as reported by London, I. D. Psychological Abstracts, Vol. XXXIV, 1960, p. 85.

Rudisill, M., "Children's Preferences for Color Versus Other Qualities in Illustrations," Elementary School Journal, Vol. 52, 1951-52, pp. 444-457.

Ruesch, J., and W. Kees, Nonverbal Communication, Berkeley and Los Angeles: University of California Press, 1956.

Rushton, W. H., "Peripheral Coding in the Nervous System," Sensory Communication, edited by W. A. Rosenblith, New York: Wiley, 1961, pp. 169-181.

Ryan, J. H., and S. Budner, "The Impact of Television: An Evaluation of the Use of Videotapes in Psychiatric Training," New York State Psychiatric Institute, New York, American Journal of Psychiatry, Vol. 126, No. 10, April, 1970, pp. 1397-1403.

Ryans, D. G., "The Role of Television in an Instructional System," Instructional Television--ITV Research, Systems Analysis, Waltham, Mass.: Brandeis University, 1963, paper prepared for the Conference on Economics of Educational Television.

Ryans, D., H. Silberman, and R. Egbert, Technical Memorandum, Santa Monica, California: System Development Corporation, November 20, 1961.

Sabo, R. A., and J. W. Hagen, "Color Cues and Rehearsals in Short-Term Memory," Child Development, Vol. 44, March, 1973, pp. 77-82.

Saettler, Paul, "Instructional Technology," AV Communication Review, Vol. XV, Summer, 1967, pp. 133-144.

Sakano, Noboru, "Functional Asymmetry and Its Significance to Human Development," Japanese Psychological Review, Vol. 13, No. 1, July, 1970, pp. 38-53.

Salomon, G., What Does It Do To Johnny? A Cognitive-Functionalistic View of Research on Media, June, 1959.

Saltz, E., "Compound Stimuli in Verbal Learning: Cognitive and Sensory Differentiation Versus Stimulus Selection," Journal of Experimental Psychology, Vol. 66, 1963, pp. 1-5.

Saul, Ezra V., and others, A Review of the Literature Pertinent to the Design and Use of Effective Graphic Training Aids, Technical Report, SPECDEVCEN 494-08-1, October, 1954.

Schaps, E., and L. Guest, "Some Pros and Cons of Color TV," Journal of Advertising Research, Vol. 8, 1968, pp. 28-39.

Schlater, R., "Effect of Speed of Presentation on Recall of Television Messages," Journal of Broadcasting, Vol. 14, No. 2, Spring, 1970, pp. 207-214.

*Schramm, Wilbur L. (ed.), Quality in Instructional Television, Honolulu: University Press of Hawaii, 1972.

Schramm, Wilbur, The Effects of Television on Children and Adolescents, an annotated bibliography with an overview of research results, reports and papers on Mass Communication, Paris, France: UNESCO, 1964.

Schramm, W., "What We Know about Learning from Instructional Television," Educational Television: The Next Ten Years, edited by W. Schramm, California: The Institute of Communication Research, Stanford University Press, 1962, pp. 52-76.

Schramm, Wilbur L., and Donald F. Roberts, ed., The Process and Effects of Mass Communication, Urbana, Illinois: University of Illinois Press, 1971.

Schramm, W., et al., The Context of Instructional Television, Summary Report of Research Findings, The Denver-Stanford Project, Title VII, Project No. 354-1964.

Scollon, R. W., Jr., Relative Effectiveness of Several Film Variables in Modifying Attitudes: A Study of the Application of Films for Influencing the Acceptability of Foods, Technical Report SDC 269-7-60, Port Washington, NY: U. S. Naval Special Devices Center, 1956.

Segall, M. H., D. T. Campbell, and M. J. Herskovits, The Influence of Culture on Visual Perception, New York: Bobbs-Merrill, 1966.

Seibert, W. F., Instructional Television: The Best of ERIC, Stanford U., California: ERIC Clearinghouse on Educational Media and Technology, Department of Health, Education, and Welfare, Office of Education, Washington, D. C., Contract No. OEC-1-7-070-873-4581, April, 1972, (ED 062-830).

Severin, W., "The Effectiveness of Relevant Pictures in Multiple Channel Communications," AV Communication Review, Vol. 15, No. 4, 1967, pp. 386-401.

Severin, Werner, "Another Look at Cue Summation," AV Communication Review, Vol. 15, Fall, 1967, pp. 233-245.

Shannon, C. E., and W. Weaver, The Mathematical Theory of Communication, Urbana, Ill.: University of Illinois Press, 1949.

Shayon, Robert Lewis, "The Communications Gap in the Classroom," Audiovisual Instruction, Vol. VI, June, 1961, pp. 244-250.

Sheffield, F. D., and N. Maccoby, "Summary and Interpretation of Research on Organizational Principles in Constructing Filmed Demonstrations," Student Response in Programmed Instruction, edited by A. A. Lumsdaine, Washington, D.C.: National Academy of Sciences, National Research Council, 1961, pp. 117-131.

Siegel, L., and L. C. Siegel, "The Instructional Gestalt," AV Communication Review, Vol. XII, Spring, 1964, pp. 16-45.

Silverman, R. E., The Comparative Effectiveness of Animated and Static Transparencies, Technical Report No. HAVTRADEVCEN 78-1, Instructional Film Research Program, Pennsylvania State University, Port Washington, NY: U. S. Naval Training Devices Center, Office of Naval Research, April 1968.

Sisler, G., "Student Reaction to an Audiotutorial System," Journal of Home Economics, Vol. 61, No. 1, January, 1970, pp. 40-42.

Skinner, T. D., "An Experimental Study of the Effects of Prestige and Delivery Skill in Educational Television," Abstracts of Doctoral Dissertations, University of Michigan, Ann Arbor, 1963.

Slattery, M. J., "An Appraisal of the Effectiveness of Selected Instructional Sound Motion Pictures and Silent Filmstrips in Elementary School Instruction," Washington: The Catholic University of America Press, 1953.

Smith, K. U., "The Scientific Principles of Textbook Design," AV Communication Review, Vol. 8, 1960, pp. 27-49.

Smith, K. U., and M. F. Smith, Cybernetic Principles of Learning and Educational Design, New York: Holt, Rinehart, and Winston, 1966.

Snow, R. E., and G. Salomon, Aptitudes and Instructional Media, Project on Individual Differences in Learning Ability as a Function of Instructional Variables, Technical Report Number 3, Stanford U., California, School of Education, HEW/OE Bureau of Research, BR-6-1269, Contract No. OEC-4-6-061269-1217, May, 1968.

Snow, R. E., and G. Salomon, "Aptitudes and Instructional Media," AV Communication Review, Vol. 16, No. 4, 1968, pp. 341-357.

Spaulding, Seth, "Communication Potential of Pictorial Illustration, AV Communication Review, Vol. IV, Winter, 1956, pp. 31-46.

Spaulding, Seth, "Research on Pictorial Illustration," AV Communication Review, Vol. III, Winter, 1955, pp. 35-45.

Stake, R. E., and D. D. Sjogren, "Activity Level and Learning Effectiveness," NDEA Title VII Project No. 753, Lincoln: University Nebraska, 1954.

Stevens, N. G., Educational Trends, Innovations, Technology, Multi-Media, Taxonomies of Learning Librarianship: A Bibliographical Checklist, 1965-1971. Kutztown State College, Pa.: Educational Development Center Report No. R-6, May, 1972.

Stevenson, H. W., Television and the Behavior of Preschool Children, Minneapolis, Minnesota: University of Minnesota, 1971.

Stickell, D. W., "A Critical Review of the Methodology and Results of Research Comparing Televised and Face-to-Face Instruction," Unpublished doctoral thesis, Pennsylvania State University, 1963, (cited by L. P. Greenhill, "Research on Instructional Television Past and Future," Improvement of Teaching by Television, edited by B. L. Griffith and D. W. MacLennan, et al., Columbia, Mo.: University of Missouri Press, 1964. pp. 17-21).

Sumby, W. H., and I. Pollack, Short-Term Processing of Information, HFORL Report, TR-54-6, January, 1954.

Symposium on Psychology of Learning Basic to Military Training Problems, Washington, D.C.: Panel on Training Devices, Committee on Human Resources, Research and Development Board, May 7-8, 1953, p. 17.

Taber, J. I., R. Glaser, and H. H. Schaefer, Learning and Programmed Instruction, Reading, Mass.: Addison-Wesley, 1965.

Taylor, I. A., "Perception and Visual Communication," in John Ball, ed., Research, Principles, and Practices in Visual Communication, Department of Audiovisual Instruction, NEA, 1960.

Taylor, Stanford E., "Sensation and Perception, The Complexity of Word Perception," Journal of Developmental Reading, Vol. 6, 1963, pp. 187-206.

Thatcher, J. W., and W. S. Y. Wang, The Measurement of Functional Load, USAF OSR Report, No. 8, 1962.

The National Cable Television Association, Cable Television and Education: A Report from the Field, Washington, D. C., 1973.

Thomas, H., "Visual Fixation Responses of Infants to Stimuli of Varying Complexity," Child Development, Vol. 36, 1965, pp. 629-638.

Thornton, J. W., Jr., and J. W. Brown, New Media and College Teaching, Washington, D. C., American Association for Higher Education, Department of Audiovisual Instruction, 1968.

Tonkonogii, I. M., and L. I. Tsukkerman, "Information Theory Approach to the Study of Perceptual Abnormalities," Voprosy Psikhologii, Vol. I, 1965, pp. 83-92.

Tolliver, Don L., A Study of Color in Instructional Materials and Its Effects Upon Learning, Purdue U., March, 1972.

Torkelson, Gerald M., Educational Media: What Research Says to the Teacher, Washington, D.C.: Association of Classroom Teachers of the National Education Association, 1972 (#14).

Tosti, D. T., J. R. Ball, A Behavioral Approach to Instructional Design and Media Selection, Final Report, 1968, Behavioral Systems Division, Westinghouse Learning Corporation, Albuquerque, New Mexico.

Travers, R. M. W., "A Study of the Advantages and Disadvantages of Using Simplified Visual Presentations in Instructional Materials," Final Report on USOE Grant No. OEG-1-7-070144-5235, 1969.

Travers, R. M. W., Man's Information System, Scranton, Pennsylvania: Chandlers, 1970.

*Travers, R. M. W., "The Design of Pictures for Teaching Children in Elementary School," AV Communication Review, Vol. 10, 1970, pp. 47-64.

*Travers, R. M. W., "The Transmission of Information to Human Receivers," AV Communication Review, Vol. XII, Winter, 1964, pp. 373-385.

Travers, R. M. W., Research and Theory Related to Audiovisual Information Transmission, Salt Lake City: University of Utah, 1964.

*Travers, R. M. W., "Research and Theory Related to Audiovisual Information Transmission" (rev. ed.), Final Report, Contract No. 3-20-003, U. S. Office of Education, Kalamazoo, Michigan: School of Education, Western Michigan University, 1967.

Travers, R. M. W., "Studies Related to the Design of Audiovisual Teaching Materials," Final Report, Contract No. 3-20-003, U. S. Office of Education, Kalamazoo, Michigan: School of Education, Western Michigan University, May 1966.

*Travers, R. M. W., and V. Alvarado, "The Design of Pictures for Teaching Children in Elementary School," AV Communication Review, Vol. 18, No. 1, Spring, 1970, pp. 47-64.

Twelker, P. A., "Rules, Answers, and Feedback in Learning, Retention, and Transfer of Concepts," (paper for the AERA meeting, February, 1965), Monmouth, Oregon: Teaching Research Division, Oregon State System of Higher Education, 1965.

Twyford, L., Film Profiles, Pennsylvania State University Instructional Film Research Program, (Technical Report SDC 269-7-23) Port Washington, NY: U. S. Naval Special Devices Center, 1951.

Ukraintsev, B. S., "Information and Reflection," Voprosy Filosofi, Vol. XVII, 1963, pp. 26-38.

Uliassi, Edward C., "An Editorial Note," Studies in Public Communication, No. 3, 1961, pp. vii-ix.

University of Illinois, Division of Communications, "How Pictures and Graphs Aid Learning from Print," Human Resources Research Institute Memo No. 11, 1953.

Urmer, A. H., "Performance Degradation Effects of Information Overloading," Perceptual & Motor Skills, Vol. XXIII, 1966, pp. 1117-1118.

Usov, V. V., "Optimization of the Channel of Information Transmission in the Process of Adaptation of the Visual Analyzer," Biofizika, Vol. VII, 1962, pp. 328-332.

Van Mondfrans, A. P., "An Investigation of the Interaction Between the Level of Meaningfulness and Redundancy in the Content of the Stimulus Material, and the Mode of Presentation of the Stimulus Material," unpublished master's thesis, University of Utah, 1963.

Van Mondfrans, A. P., and R. L. Houser, "Selecting Media to Present Basic Concepts," Educational Technology, Vol. 11, No. 4, 1970, pp. 40-43.

Van Mondfrans, A. P., and R. M. W. Travers, "Learning of Redundant Material Presented through Two Sensory Modalities," Perceptual & Motor Skills, Vol. XIX, 1964, pp. 743-751.

VanderMeer, A. W. and H. E. Thorne, "An Investigation of the Improvement of Informational Filmstrips and the Derivation of Principles Relating to the Effectiveness of These Media," Study No. 1, University Park: College of Education, Pennsylvania State University, n.d.

VanderMeer, A. W., "An Investigation of the Improvement of Informational Filmstrips and the Derivation of Principles Relating to the Effectiveness of These Media," Study No. 2, University Park: College of Education, Pennsylvania State University, n.d.

VanderMeer, A. W., and R. Montgomery, "An Investigation of the Improvement of Informational Filmstrips and the Derivation of Principles Relating to the Effectiveness of These Media," Study No. 3, University Park: College of Education, Pennsylvania State University, n.d.

VanderMeer, A. W., Relative Effectiveness of Color and Black and White in Instructional Films, (Technical Report SDC 269-7-28) Port Washington, NY: U. S. Naval Special Devices Center, 1952.

VanderMeer, A. W., "Color vs Black and White in Instructional Films," AV Communication Review, Vol. 2, 1954, pp. 121-134.

VanderMeer, A. W., Training Film Evaluation: Comparison Between Two Films on Personal Hygiene: TF8-155 and TF8-1665, (Technical Report SDC 269-7-50) Port Washington, NY: U. S. Naval Special Devices Center, 1953.

VanderMeer, A. W., J. Morrison, and P. Smith, "An Investigation of the Improvement of Educational Motion Pictures and a Derivation of Principles Relating to the Effectiveness of These Media," University Park: College of Education, Pennsylvania State University, 1965.

Vernon, M. D., A Further Study of Visual Perception, Cambridge University Press, 1952.

Vernon, M. D., The Psychology of Perception, Penguin Books, Baltimore, Maryland, 1962.

Vernon, P. E., "An Experiment on the Value of Film and Filmstrip in Instruction of Adults," British Journal of Educational Psychology, Vol. XVI, 1946, pp. 149-162.

Vestal, D. A. "The Relative Effectiveness in the Teaching of High School Physics of Two Photographic Techniques Utilized by the Sound Motion Picture," Abstracts of Doctoral Dissertations, University of Nebraska, Vol. 13, Lincoln: University of Nebraska, 1952.

Vincent, W. S., and others, Relationship of Length and Fact Frequency to Effectiveness of Instructional Motion Pictures, University Park, Pennsylvania State University, College of Education, Port Washington, New York, Special Devices Center: Office of Naval Research, (Report No. TR-SDC-269-7-7) November, 1949.

Vitz, P. C., "Preference for Different Amounts of Visual Complexity," Behavioral Science, Vol. 11, 1966, pp. 105-114.

Vuke, G. J., "Effects of Inserted Questions in Films on Developing an Understanding of Controlled Experimentation," Dissertation Abstracts, Vol. 23, 1963, p. 2453.

Wade, S. E., "Effects of Television Utilization Procedures on Learning," AV Communication Review, Vol. 17, No. 3, Fall, 1969, pp. 283-290.

Wade, S. E., The Effect of Different Television Utilization Procedures on Student Learning, Final Report, San Jose, California: Santa Clara County Office of Education, HEW/OE Bureau of Research, BR-7-1-047, Grant No. OEG-1-7-070047-3883, April, 1968.

Webb, W. B., and E. J. Wallon, "Comprehension by Reading Versus Hearing," Journal of Applied Psychology, Vol. XL, 1956, pp. 237-240.

Weiss, W., and G. Margolius, "The Effect of Context Stimuli on Learning and Retention," Journal of Experimental Psychology, Vol. 48, 1954, pp. 318-322.

Wells, R. F., "A Study to Determine Whether General Concepts Which are Commonly Taught by Motion Pictures can be Learned as Effectively by Sequential Still Photographs during Traditional Versus Self-Paced Study Periods," (Doctoral Dissertation, Purdue University) Ann Arbor, Michigan: University Microfilms, 1970. No. 23674.

*Wells, R. F., A. P. Von Mondfrans, S. N. Postlethwait, and D. C. Butler, "Effectiveness of Three Visual Media and Two Study Formats in Teaching Concepts Involving Time, Space, and Motion," AV Communication Review, Vol. 21, No. 2, Summer, 1973.

Wepman, J., "Auditory Discrimination, Speech and Reading," Elementary School Journal, Vol. LX, 1960, pp. 325-333.

Westley, B. H., and J. B. Mobius, "The Effects of 'Eye-Contact' in Televised Instruction," Research Bulletin No. 14, Madison: University of Wisconsin Television Laboratory, December 15, 1960.

White, B. L., J. C. Watts, et al., Major Influences on the Development of the Young Child, Englewood Cliffs, New Jersey: Prentice-Hall, 1972.

*Wiener, Norbert, Cybernetics,or Control and Communication in the Animal and the Machine, The MIT Press and John Wiley & Sons, Inc, New York, London, 1961.

*Wiener, Norbert, The Human Use of Human Beings: Cybernetics and Society, second edition revised, Garden City, NY: Doubleday and Co., Inc., Anchor Books edition, 1954.

Winick, M., "Food, Time, and Cellular Growth of the Brain," New York Journal of Medicine, Vol. 69, No. 2, 1969, pp. 302, 304.

Winick, M., and P. Ross, "The Effect of Severe Early Malnutrition on Cellular Growth of Human Brain," Pediatric Research, Vol. 3, No. 2, 1969, pp. 181-184.

Witkin, H. A., R. B. Dyk, H. F. Faterson, D. R. Goodenough, and S. A. Karp, Psychological Differentiation, John Wiley and Sons, Inc., New York, 1962.

Wolf, W., and others, A Study of Eye Movement in Television Viewing, Final Report, Ohio State University, Columbus Research Foundation, (Department of Health, Education, and Welfare, Office of Education, Washington, D. C., Bureau of Research, Bureau No. BR-5-0427, Grant No. OEG-7-45-0430-234) August, 1970.

Worth, S., "Aspects of Visual Communication," AV Communication Review, Vol. XVI, Summer, 1968, pp. 121-145.

Wulff, J. J., Summary of an Experimentation. The Teaching Effectiveness of a Filmed Mechanical Assembly Demonstration with Supplementary Nomenclature Training, New Haven, Conn.: Yale University Press, September, 1954.

Yamamoto, K., "Stimulus Mode and Sense Modality: What's in it for Education?" Teachers College Record, Vol. 70, 1969, pp. 513-521.

Zettl, H. L., The Use of Television in Adult Education: Research Evidence and Theoretical Considerations, Berkeley: University of California, 1966 (Ph.d. Thesis).

Zuckerman, J. V., Music in Motion Pictures: Review of Literature with Implications for Instructional Films, Technical Report SDC 269-7-2, Port Washington, NY: U. S. Naval Special Devices Center, 1949.

Zuckerman, J. V., "Predicting Film Learning by Pre-Release Testing," AV Communication Review, Vol. 2, 1954, pp. 49-56.

Zuckerman, J. V., Commentary Variations: Level of Verbalization, Personal Reference, and Phase Relations in Instructional Films on Perceptual-Motor Tasks, Technical Report SDC 269-7-4, Pennsylvania State University Instructional Film Research Program, Port Washington, NY: U. S. Naval Special Devices Center, 1955.